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EDITORIAL

GRAVEL CONCRETE

There has been much discussion over the relative values of gravels of various grading of sizes for making concrete, but the number of tests has been small and the tendency has been to follow the specifications which have been developed for the harder varieties of crushed stone: We are able to present this month the results of some tests to determine the relative values of two grades of gravel, one having been passed thru a screen with 1¼-inch holes and held on one of ¼-inch mesh, the usual specification, and the other having the same upper limit and held on ⅛-inch mesh.

Curves 3 and 4, on Plate III, show the proportions of each size of material in each of the grades. From this it will be noted that the gravel held on the smaller mesh contains 52½ per cent. of material less than ¼-inch in size, and ¼-inch gravel contains about 17½ per cent. of less than ¼-inch size, probably because screened from the bank when somewhat moist, and because it was run rapidly over the screens. The difference is 35 per cent., which is approximately the amount of clean material rejected by the ¼-inch specification. This material is practically waste at the gravel plant, which is expensive to get rid of or at best must usually be sold at a very low price.

The results of these tests indicate that the rejection of this material between ⅛ and ¼ inch in size is not an advantage to the concrete, but, on the contrary, appears to be an appreciable disadvantage. The proportion of cement being the same in both sets of tests, this excess of strength in the aggregate held on the ⅛-inch screen may be due to the fact that the percentage of voids, as shown on Plate I, is but 32½ per cent. as compared with 36½ per cent. in the larger aggregate, so that the mortar filled the voids more completely in the former case.

This set of tests is the first of a series which it is proposed to make for the purpose of determining as nearly as may be the most economical and advantageous proportions of cement, sand, and larger aggregate in gravel concrete, as well as the proper gradation of sizes in the gravel and in the sand and the best point at which to make the division between gravel and sand for gravel concrete purposes at least.

The practical result of a specification embodying the results of these tests would be a reduction in the price of gravel roughly proportional to the 35 or more per cent. of the finer materials admitted and thus saved to the consumer, and a consequent reduction in the cost of gravel concrete. It is possible that the other tests in prospect will reduce the amount of cement required. At any rate they will give information on which to base the most economical and efficient proportions of cement, sand and gravel.

HIGHWAY LOCATION

The wrangle over the Dixie Highway has reached an apparent deadlock in the effort to select one line for the route, and a half dozen routes, each with its variations in choice of connections at common points, are now clamoring for precedence. The demand for an inter-county system of good roads and for an inter-state system of main highways is becoming each day more insistent as a consequence of the publicity given to the seemingly insurmountable difficulties in making a choice.

There is no trouble in states having the inter-county road systems in operation or under construction, because the roads are there or are provided for in the near future, and the tourist or traveler can have his choice of good roads. But in the states on this north-and-south line between the lakes and the gulf or the southeastern Atlantic coast, there are either no state road systems or the organizations are not yet strong enough to push the location and improvement of the roads as fast as they are needed.

It is very evident that these thru lines are called for by the long-distance travelers, and that they should help pay for them. It is also very evident that the difficulties in the way of the location of the main line arise from the demands of the localities which would be affected by the location that the route pass thru their districts. So it is evident that the local districts should help pay for the roads in the proportion that they would benefit by them.

Is it not clear as day-light, therefore, that a system of building the main highways should be established which will insure the building of the roads and making them good enough to carry all the traffic that will come to them, local and thru, carriage, wagon, automobile, truck, or traction engine as the case may be; and that will distribute the cost where it belongs, a small part on the farmers who have probably laid the foundations for the roads already, a larger part on the county whose inhabitants will use it largely, and still more upon the residents of the state and of other states, whose convenience and business will be served by them.

While such rancorous wrangles are ordinarily unfortunate, this one, and others like it but less strenuous, bid fair to develop a sentiment along the lines, which together cover a large part of the states seeking the location of the roads, which will demand of the legislatures to come adequate laws to insure good design and construction, and to distribute the cost properly, so that it will not all fall upon the abutting property or the local township. Then every main north-and-south road will be a Dixie Highway, and every east-and-west main road will be a Transcontinental Highway, and no city or town of importance will be left off the line.

GRAVEL AGGREGATE *for* CONCRETE

By Professor W. K. Hatt, Director of Laboratory for Testing Materials,
Purdue University, Lafayette, Indiana.

The series of tests on gravel concrete, of which this is a report, was made by the author in response to a request made by the Indiana Sand and Gravel Producers' Association, whose officers are H. C. Huffstetter, president, Indianapolis; J. E. Swango, vice-president, Terre Haute; B. E. Neal, treasurer, Indianapolis, and V. G. Pogue, secretary, Indianapolis.

This organization wished to know the difference in value for the purposes of making concrete of gravel passing a 1½-inch screen and held on a ¼-inch mesh and held on a 5/32-inch mesh, termed 1½ to ⅛-inch size. The request stated the association's desire that the material be subjected to all the tests usually made in determining the value of concrete aggregates; that the voids in the two gravel aggregates and in the sand used be determined, and the proportions of cement, sand and aggregate be stated.

The results are of great interest, especially where gravel is the standard aggregate, and add much to our knowledge of the action of this standard material for making concrete.

The report is addressed to the association and is given in full.

Introductory Note.—Specifications for concrete to be made of gravel and sand usually state that the fine aggregate shall be "graded from fine to coarse and passing when dry a screen having ¼-inch openings" and that the coarse aggregate shall be retained on a screen having ¼-inch openings.

The specifications ordinarily indicate the proportions to be used. An arbitrary proportion of 1:2:4, which is commonly used, provides that 2 parts of finer aggregate and 4 parts of coarse aggregate, measured by volume, be mixed with the required amount of cement. This results in a large waste of fine material since the natural gravel bank usually has an excess of the material ranging from ⅛-inch to ¼-inch in size.

If the "fine aggregate" were graded down from the ⅛-inch instead of the ¼-inch and the coarse aggregate graded up from the ⅛-inch instead of the ¼-inch, there would be approximately twice as much of the material from ⅛-inch to ¼-inch used in filling a specification similar to 1:2:4 by volume. This would result in less waste of fine material and, if the quantity of the resulting concrete were not materially affected, would result in an economic gain.

Purpose of Tests.—The tests hereinafter reported were made to ascertain the relative strength of concrete of an arbitrary 1:2:4 proportion: (1) When the line of division between the fine aggregate and the coarse aggregate is the ⅛-inch sieve, and, (2) When it is the ¼-inch sieve.

Scope of the Tests.—The following is an outline of the tests which have been made in this investigation:

(1) Preliminary Tests:
  (a) Determination of specific gravity of sand and and gravel.
  (b) Determination of effect of contained moisture on the weight per cubic foot and per cent. voids.
  (c) Sieve analysis of the dry aggregates.
(2) Relative Value of the fine aggregates, i. e., below ⅛-inch screen and below ¼-inch screen, as shown by strength of 1 to 3 mortar.
(3) Relative strength of concrete in arbitrary 1:2:4 proportion; measurement being on basis of moist volumes fairly loose.

Materials Used in the Tests.—Two shipments of sand and gravel were received for the tests. The material was said to have been taken from the plant of the Brown-Huffstetter Sand Co., under the supervision of Mr. W. C. Shoemaker, of the Atlas Sand and Gravel Co., both of Indianapolis, Ind. The samples were said to have been taken from cars ready for shipment to customers.

The moisture content in the samples as determined soon after arrival was as follows:

Material	Shipment No. 1	Shipment No. 2
⅛-inch sand	3.05 per cent.	2.96 per cent.
¼-inch sand	2.10 per cent.	3.43 per cent.
⅛-inch gravel	1.81 per cent.	——
¼-inch gravel	1.66 per cent.	——

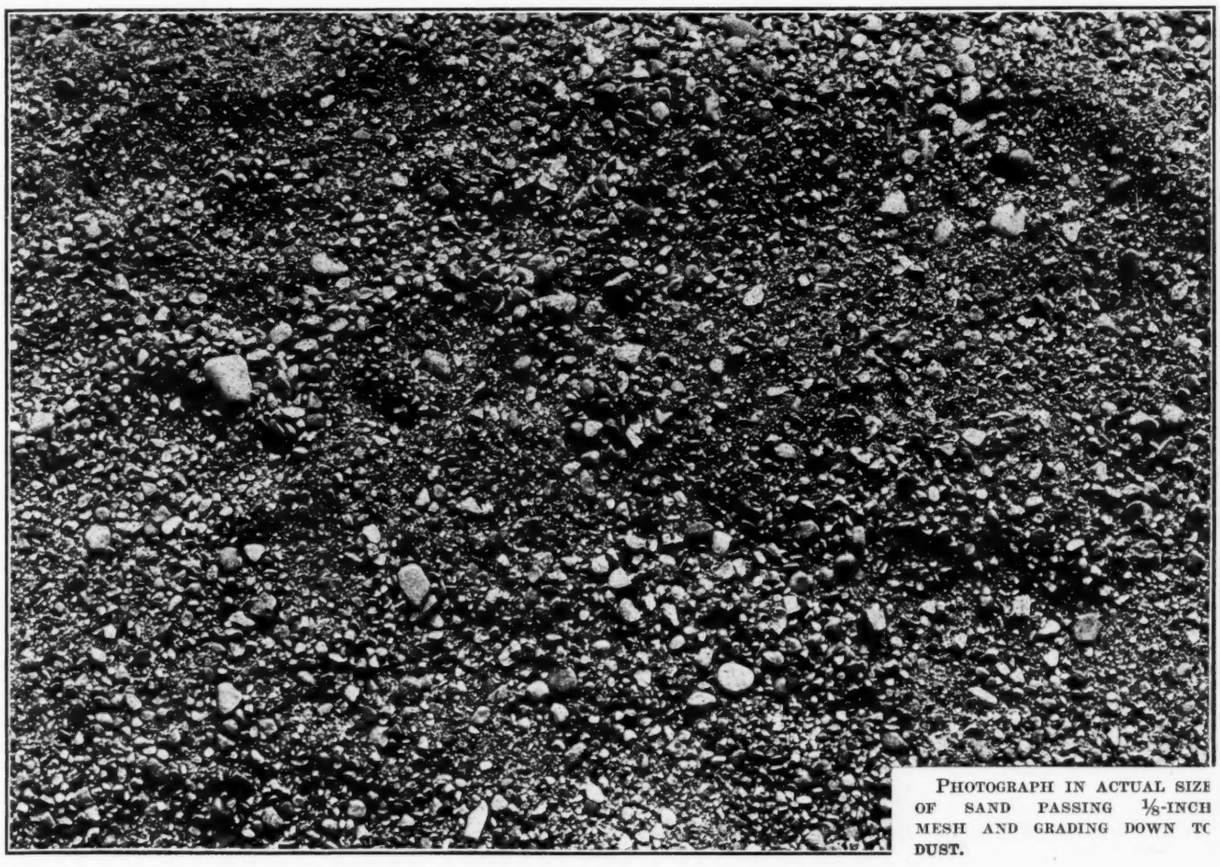
(Percentages on basis of dry weights.)

The sand and gravel were clean, with no clay or silt present. The relative size and appearance of these aggregates may be seen from the photographs accompanying this report.

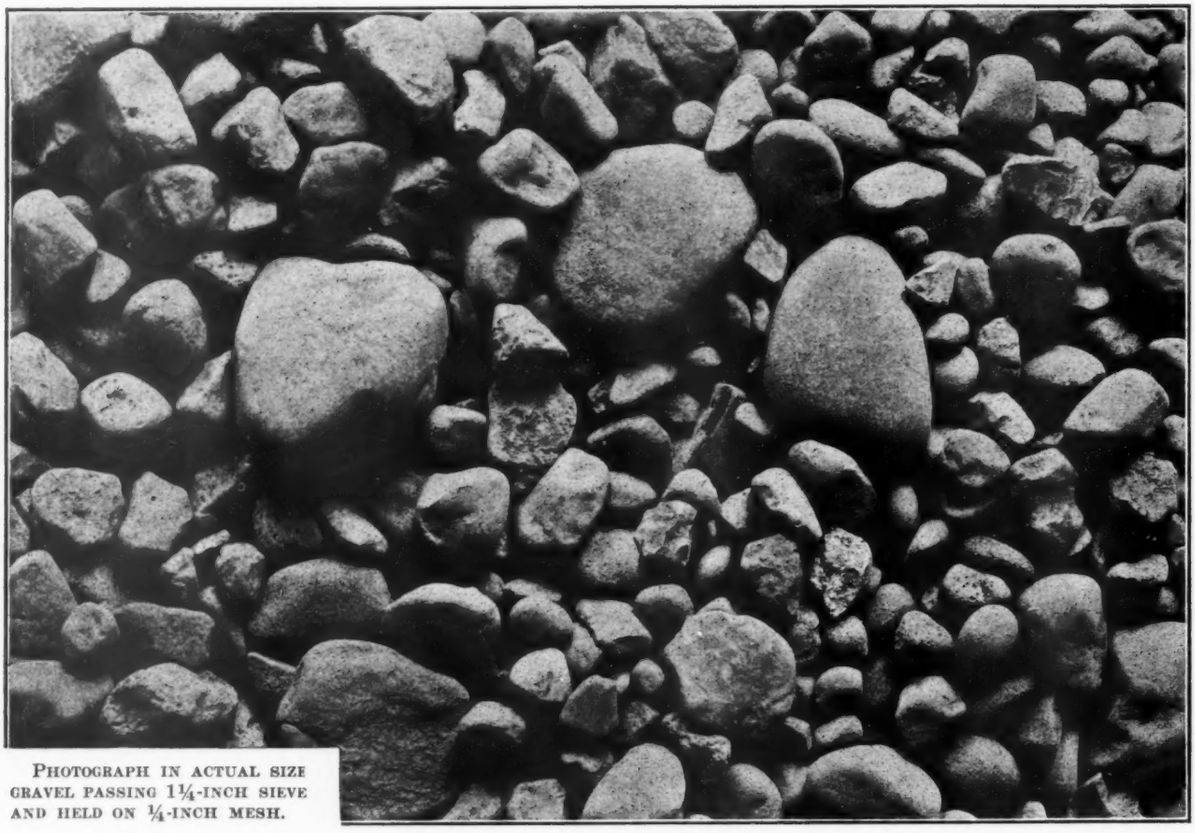
METHOD OF TEST.

(1) *Preliminary Tests.*
  (a) Determination of Specific Gravity.
  Two determinations were made for each sample by the method of introducing a given weight of aggregate into a graduate containing a given volume of water.
  (b) Sieve Analysis of Aggregate.
  Two determinations were made for each sample. The dry aggregates were separated into their constituent sizes by means of a set of Tyler standard screen scales. The percentage by weight passing the various size screens was determined.
  (c) The effect of the contained moisture on the weight per cubic foot and per cent. voids of the fine aggregates. This determination consisted in obtaining the weight of a given volume of fine aggregate with different amounts of contained moisture. To approximate conditions of practice, the material was shoveled from the floor into the measuring vessel as in service.
(2) *Relative Value of Fine Aggregates*, as shown by strength of 1 to 3 mortar.
  Two-inch cubes for compression tests were made, using 1 part by weight of a mixture of Alpha, Atlas, Lehigh and Universal cements to 3 parts of dry fine aggregate. Two-inch cubes were also made up, using the same materials, but the proportions were by loose volumes as in service with an average moisture content. The test pieces were tested in in compression at end of 7, 28, 47 and 52 days.
(3) *Relative Strength of Concrete* of ⅛-inch separated material and of ¼-inch separated material for an arbitrary 1:2:4 proportion, measurement being on basis of moist volumes fairly loose.

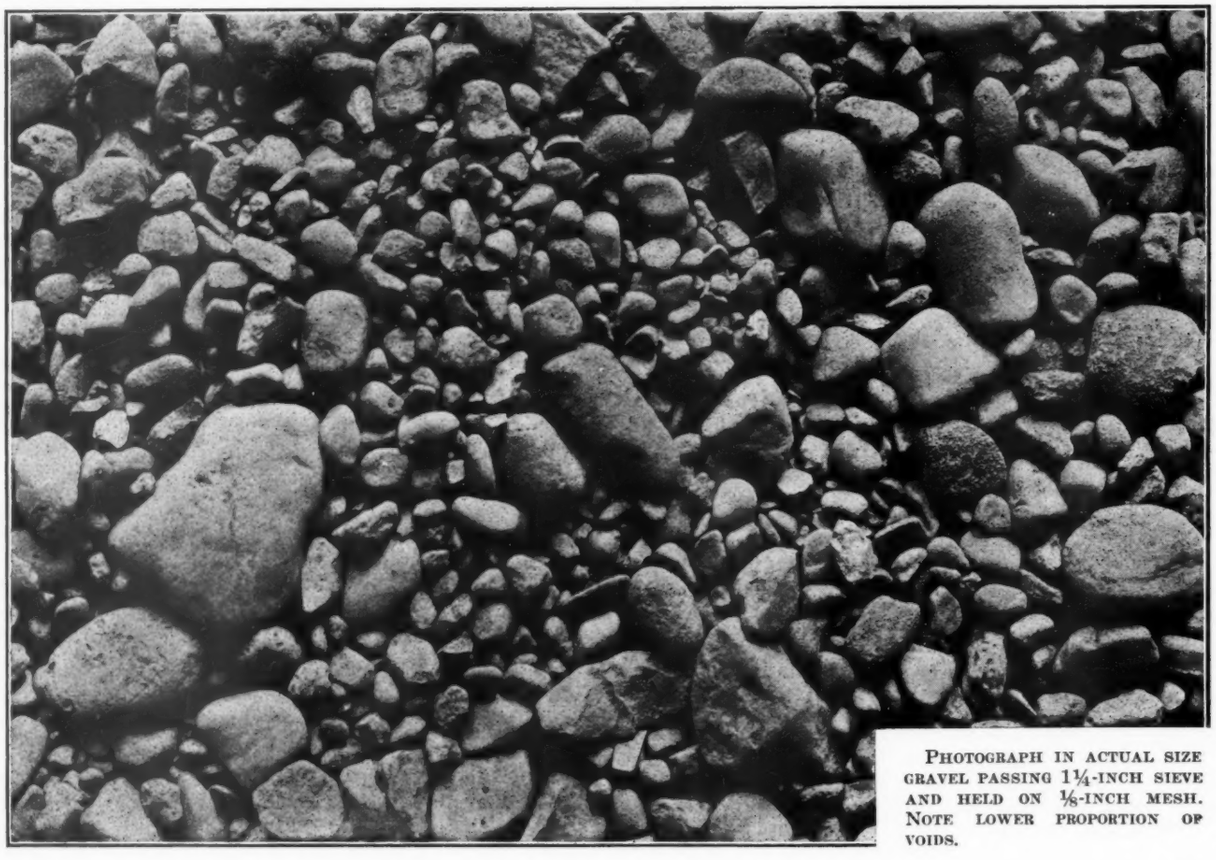
PHOTOGRAPH IN ACTUAL SIZE OF SAND PASSING ¼-INCH MESH AND GRADING DOWN TO DUST.



PHOTOGRAPH IN ACTUAL SIZE OF SAND PASSING ⅛-INCH MESH AND GRADING DOWN TO DUST.



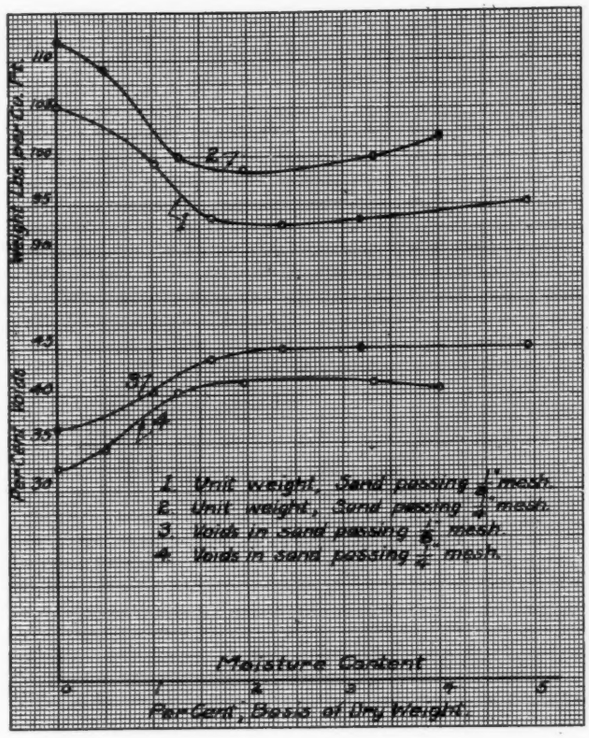
PHOTOGRAPH IN ACTUAL SIZE GRAVEL PASSING 1¼-INCH SIEVE AND HELD ON ¼-INCH MESH.



PHOTOGRAPH IN ACTUAL SIZE GRAVEL PASSING 1¼-INCH SIEVE AND HELD ON ⅛-INCH MESH. NOTE LOWER PROPORTION OF VOIDS.

PLATE I

RELATION OF UNIT WEIGHT AND VOIDS TO MOISTURE CONTENT


Weight Lbs per Cu. Ft.
Per Cent Voids
1. Unit weight, Sand passing ¼" mesh.
2. Unit weight, Sand passing ⅛" mesh.
3. Voids in sand passing ⅛" mesh.
4. Voids in sand passing ¼" mesh.
Moisture Content
Per Cent, Basis of Dry Weight.

In this there were two series, I and II. Two series of compression test cylinders were made, using Lehigh cement and the aggregates with an average moisture content. For accurate proportioning by volume, it was thought necessary to determine the weight per cubic foot with the moisture present, and then fractions of cubic feet by weight. This weight was determined in each case by shoveling the moist aggregate into a cubic foot measure, thus approximating commercial practice of measurement.

In each of Series I and II a set of three test pieces was made, using each size of aggregate. The conditions of manufacture were exactly the same in the case of each kind of aggregate. The various steps involved were as follows:

(a) Aggregates were brought to the same conditions as to moisture. This was judged by the eye.

(b) The weight per cubic foot was determined under approximately the conditions of commercial measurement, i. e., deposited in a measuring box by hand with a shovel.

(c) Determination of the per cent. moisture present at time of measuring.

(d) The required weight of aggregate and cement were then placed in a Chicago cube mixer and mixed for 1 minute. The water was then added and mixing continued for 3 minutes longer. All batches were mixed to the same medium wet consistency.

(e) Three 8-inch diameter by 16-inch height cylinders were molded from each batch with slight puddling and sides spaded by means of a trowel.

(f) The forms were removed from all test specimens after 1½ days. The specimens were stored under moist sand until four days before a test. They were then removed and capped with plaster of Paris to give smooth ends.

(g) Specimens were all tested at age of 28 days.

Series III and IV were made with the same methods as above, but the proportions for the mixture using material divided on the ⅛-inch screen, were varied in the attempt to produce a stronger concrete. The new proportions used were such as to make the sieve analysis curve of the mixture of cement plus aggregate, approach more closely to that of the 1:2:4 mix of the ¼-inch divided aggregate.

Series V. These specimens were made up, using an entirely different aggregate and cement. An aggregate from Lafayette banks was screened on a ¾-inch screen. The material passing the ¾-inch screen was divided and recombined according to the requirements of Fuller & Thompson's maximum density curve for cement plus aggregates.

One set of test specimens was made up, using the material divided on the No. 8 screen, and another set, using material divided on the ¼-inch screen.

The actual proportions used in Series V were as follows:

Material divided on No. 8 screen, 1:1.1:3.9 by dry weight.

Material divided on ¼-inch screen, 1:2.04:2.96 by dry weight.

RESULTS OF TESTS.

A summary of the averages of the different determinations may be found in the following tables:

Table 1. Specific Gravity. Two determinations for each material.

⅛-inch sand	Specific gravity 2.65
¼-inch sand	Specific gravity 2.645
⅛-inch-1¼-inch gravel	Specific gravity 2.655
¼-inch-1¼-inch gravel	Specific gravity 2.655

Table 2. Effect of Moisture on the Weight per cubic foot and per cent of Voids of the Fine Aggregates.

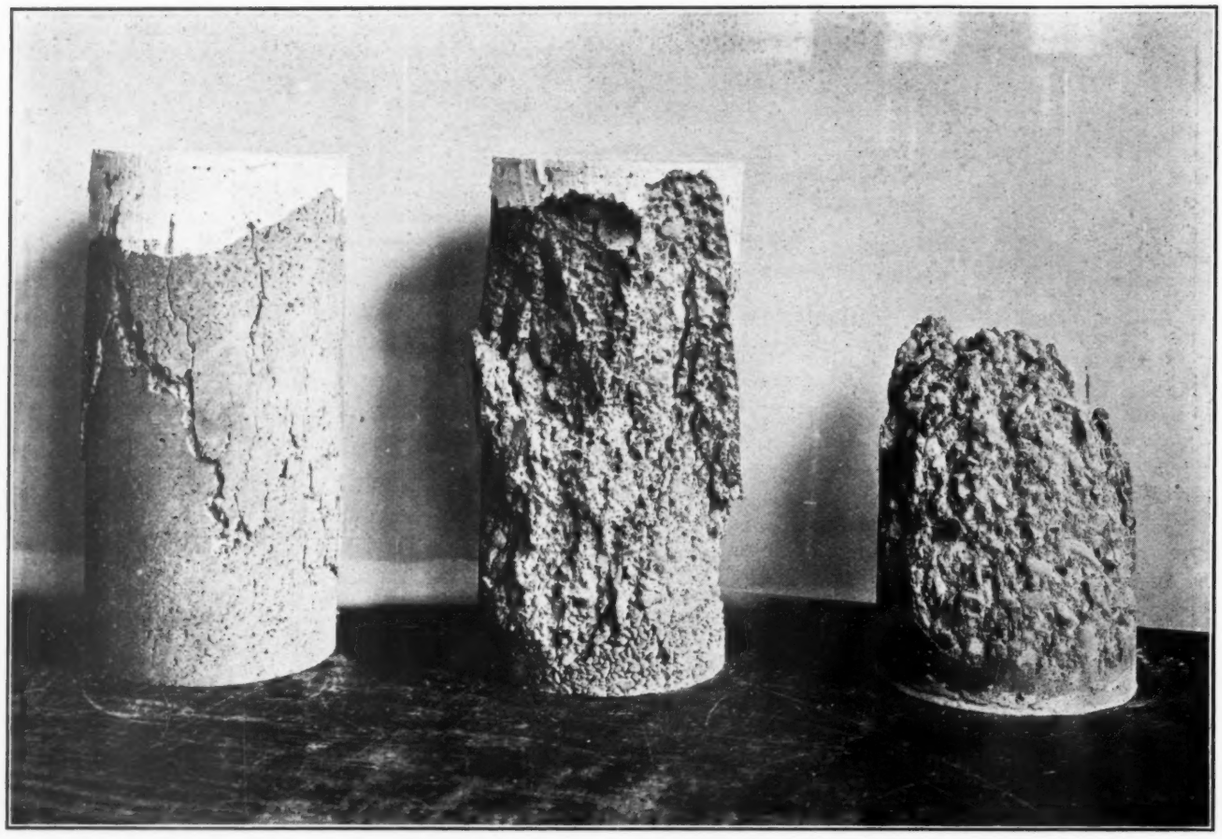
Moisture (per cent.)	Weight (lb. per. cu. ft.)	Voids (per cent.)
¼-inch Sand—		
0 (air dry)	111.8	32.4
0.5	109.0	34.2
1.28	99.9	40.2
1.96	98.7	42.25
3.31	99.9	41.3
4.01	101.8	40.7
⅛-inch Sand—		
0 (air dry)	105.2	36.5
1.64	99.4	40.3
1.64	93.7	43.9
2.36	92.8	44.8
3.18	93.4	45.0
4.94	95.3	45.0

Note—Percentage is on basis of dry weight. Material was deposited in 1 cubic foot measure by shovel.

These results are shown graphically on curve Plate I.

Table 3. Voids in the Coarse Aggregate. Three Determinations for each material.

Gravel	Moisture	Weight (lb. per cu. ft.)	Voids (per cent.)
⅛-inch to 1¼-inch	Air dry	105.8	34.1
¼-inch to 1¼-inch	Air dry	100.7	38.75



TEST CYLINDERS *after compression in testing machine. The left cylinder is one taken out at the point of failure. The central cylinder shows the characteristics of concrete with gravel aggregate held on ⅛-inch mesh. The right cylinder shows the characteristics of concrete with gravel aggregate held on ¼-inch mesh.*

Table 4. Sieve Analysis of Aggregates. Three Determinations for each material.

Sieves		Per cent. passing			
		Sands		Gravels	
No.	Size In.	⅛-in.-0-in.	¼-in.-0-in.	⅛-in.-1¼-in.	¼-in.-1¼-in.
1¼	1.25	....	....	100	100
1	1.00	....	....	99.5	98.75
¾	.75	....	....	96.3	92.4
½	.50	....	100.0	87.0	78.6
¼	.25	100.0	98.7	52.5	17.5
4	.185	99.5	90.5	....	....
6	.131	97.4	78.0	....	....
8	.093	91.2	67.3	9.1	0.1
10	.065	81.0	57.0	....	....
14	.046	69.6	47.7	....	....
16	.042	....	....	....	....
20	.0328	58.6	39.5	2.1	00
28	.0282	42.5	27.4	....	....
35	.0164	23.1	14.2	....	....
48	.0116	11.0	6.3	....	....
65	.0082	5.0	2.5	....	....
100	.0058	1.8	0.8	....	....
200	.0029	0.8	0.3	....	....

Table 5. Relative Strength of 1 to 3 Mortar Made with Each of the Fine Aggregates. Compressive strength (lb. per square inch).

	1 to 3 by weight		1 to 3 by moist loose vol.	
	⅛-in. sand	¼-in. sand	⅛-in. sand	¼-in. sand
7 days	1603	2165	2173	2575
28 days	2798	3730	3455	3843
52 days	3201	4043	*3718	*4138

Each value is average of three tests. *47 days.

Table 6. Relative Strength of Concrete in Arbitrary 1:2:4 Proportions, Measurement Being by Moist Volumes. Each value is the Average of three tests.

	Aggregates divided on ⅛-in. sieve	Aggregates divided on ¼-in. sieve
Series I—Av. Compressive Strength at 28 days (lb. per sq. inch)	3110	2890
Series II—Av. Compressive Strength at 28 days (lb. per sq. inch)	3610	3450

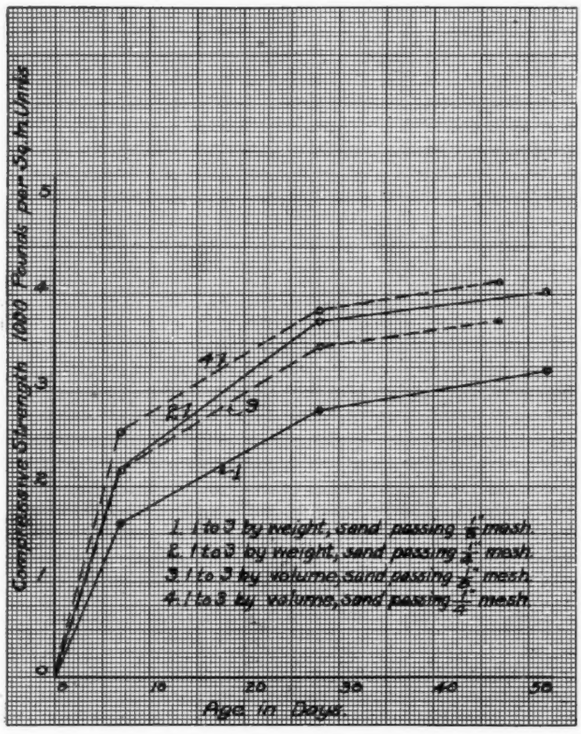
	Proportion (moist volume) 1:0.555:5.22 Aggregates divided on ⅛-in. sieve	Proportion (moist volume) 1.2.4 Aggregates divided on ¼-in. sieve
Series III—Av. Compressive Strength at 28 days (lb. per sq. inch)	2540	2118

Different batch of cement from Series I and II.

	Proportion (moist volume) 1.2.4 Aggregates divided on ¼-in. sieve	Proportions (moist volume) 1:0.534:5.22 Aggregates divided on ⅛-in. sieve
Series IV—Av. Compressive Strength at 28 days (lb. per sq. inch)	3620	4090

PLATE II

RELATIVE STRENGTH OF 1 TO 3 MORTAR
SAND PASSING $\frac{1}{4}$" MESH
SAND PASSING $\frac{1}{8}$" MESH


Compressive Strength (000) Pounds per Sq. In. Units
Age in Days
1. 1 to 3 by weight, sand passing ⅛" mesh.
2. 1 to 3 by weight, sand passing ¼" mesh.
3. 1 to 3 by volume, sand passing ⅛" mesh.
4. 1 to 3 by volume, sand passing ¼" mesh.

Proportions 1 to 5 by dry weights.

Material: Lafayette bank gravel passing ¾-inch sieve. Cement was mixture of Atlas, Alpha, Lehigh, Universal.

	Aggregates divided on No. 8 sieve	Aggregates divided on ¼-in. sieve
Series V—Av. Compressive Strength at 28 days (lb. per sq. inch)	2655	2375

DISCUSSION OF RESULTS.

1. The average specific gravity of 2.65, as given in Table 1, shows the material to be of average grade as to weight and quality.

2. Table 2 and curve Plate II illustrate the variation of each fine aggregate as to weight and voids when the contained moisture varies from 0 to 5 per cent. of the dry weight. It is seen that as the per cent. of moisture in each of the sands increases the unit weight decreases and the voids increase. An average moisture content of these sands may be taken as from 2 per cent. to 5 per cent.

On account of the change in weight and volume of these sands with a change in amount of moisture, it is necessary, for accurate work, to assume an average moisture content and then determine an average unit weight and thereafter to determine by weight amounts of material for any given proportion.

The voids are greater and the weight per cubic foot less for all moisture contents in the fine aggregate screened thru the ⅛-inch screen than in the fine aggregate screened thru the ¼-inch screen.

3. In Table 3 may be seen the voids and weight per cubic foot of the coarse aggregates. The weight is greater and the voids less in the material graded from ⅛-inch to 1¼-inch than in the material from ¼-inch to 1¼-inch.

4. The average grading of the materials as to size is shown in Table 4 and curve Plate III. By inspection of the curves and data, it will be seen that the amount of material between ⅛-inch and ¼-inch in the various aggregates is as follows:

Aggregate	Per cent, by dry weight, of contained material between ⅛-in. and ¼-in. screen.
⅛-in.-0-in.	4 per cent.
⅛-in.-1¼-in.	38.5 per cent.
¼-in.-0-in.	24 per cent.
¼-in.-1¼-in.	14 per cent.

5. The relative value of the fine aggregates as a mortar producing material is shown in Table 5 and curve Plate II.

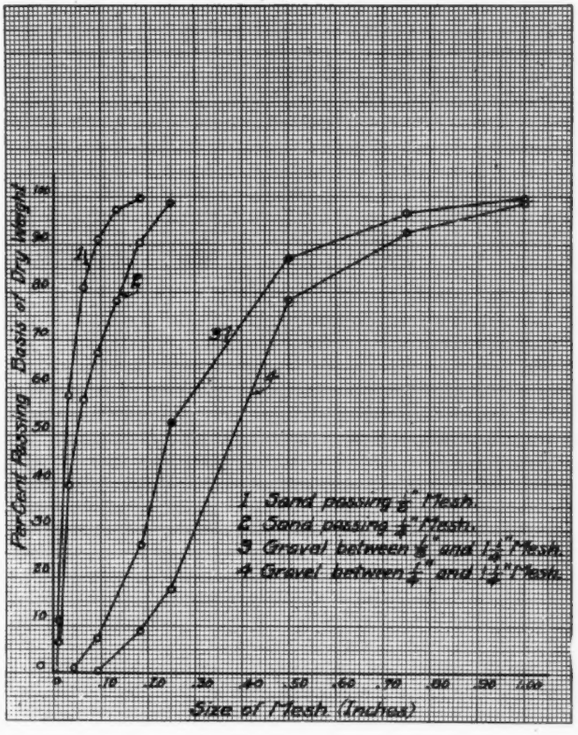
One to three mortar from ¼-inch-O sand is stronger than 1 to 3 mortar from ⅛-inch-O sand. This is probably due to its better grading. The difference in strength is less when the proportion of cement to aggregate is taken on a basis of moist loose volume as measured in practice, rather than by dry weight.

6. The strength of the concrete for a 1:2:4 proportion by volume is greater when the line of division between the fine and coarse aggregate is the ⅛-inch screen, than when line of division is the ¼-inch. This is shown by the averages from Series I and II.

In Series III and IV, Table 6, in which the amount of ⅛-inch-0 sand is reduced, the difference in strength is not so clearly defined. In Series III, the aggregate divided on the ⅛-inch screen has greatest strength, while in Series IV, using a little less of ⅛-inch-0 sand, the aggregate divided on the ¼-inch screen has the greatest strength. In Series III and IV the comparison in strength is made between the adopted standard 1:2:4 mix of aggregate divided on the ¼-inch and a

PLATE III

SIEVE ANALYSIS CURVES
OF
SAND AND GRAVEL AS RECEIVED


Per Cent Passing Basis of Dry Weight
Size of Mesh (Inches)
1. Sand passing ⅛" Mesh.
2. Sand passing ¼" Mesh.
3. Gravel between ¼" and 1½" Mesh.
4. Gravel between ½" and 1½" Mesh.

new proportion for the aggregates divided on the ⅛-inch screen, as explained in Method of Tests.

Series V indicates that for an aggregate whose maximum size of particle is ¾-inch such a proportion may be selected using materials divided on the ⅛-inch screen that the strength of the resulting concrete will be equal to, if not greater, than when the aggregates are divided on the ¼-inch screen.

No comparisons may be made between series because different batches of cement were used in making up the different series.

CONCLUSIONS.

The results of the tests as reported would seem to indicate that for the aggregate tested and the assumed proportion that the resulting concrete is as strong if not stronger when the line of division is on the ⅛-inch screen than when the line of division is on the ¼-inch screen.

Whether this would be true for all ranges of aggregates and all proportions remains a subject for further investigation.

Acknowledgement.—The skill and care of Professor Scofield in carrying out these tests are thankfully acknowledged.

PLATE IV

SIEVE ANALYSIS CURVES SHOWING MIXTURES OF CEMENT PLUS AGGREGATE IN SERIES I, II, III, IV

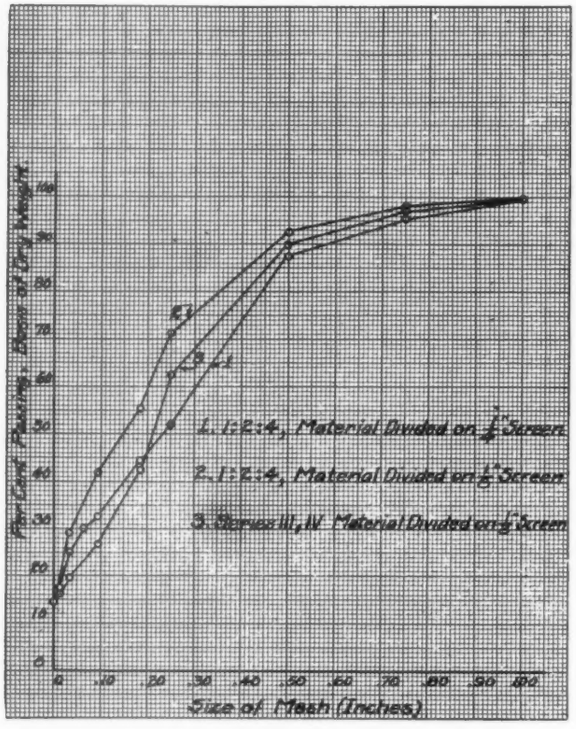
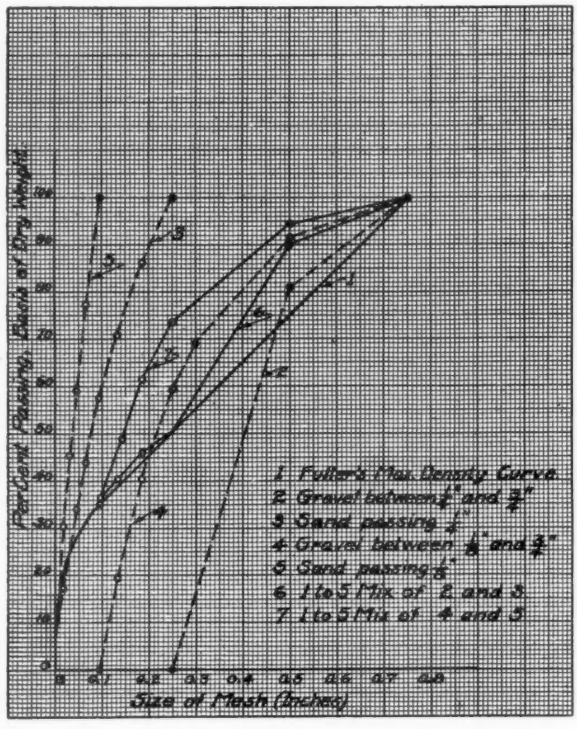

Per Cent Passing, Basis of Dry Weight
1. 1:2:4, Material Divided on ¼" Screen
2. 1:2:4, Material Divided on ⅛" Screen
3. Series III, IV Material Divided on ⅛" Screen
Size of Mesh (Inches)

PLATE V

SIEVE ANALYSIS CURVES OF AGGREGATE USED IN SERIES V


Per Cent Passing, Basis of Dry Weight
1. Fuller's Max. Density Curve
2. Gravel between ¾" and ¼"
3. Sand passing ¼"
4. Gravel between ¾" and ¼"
5. Sand passing ¼"
6. 1 to 5 Mix of 2 and 3
7. 1 to 5 Mix of 4 and 5
Size of Mesh (Inches)

CONVERTED INTO BOOSTERS FOR HARD SURFACED ROADS

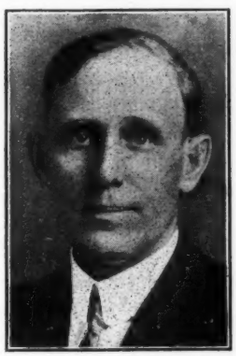
A prominent banker from Kansas City stated he had toured across New York state, thru the Adirondacks, into Vermont and the White Mountains, then to Maine and along the east coast to Boston and the shore line to New York. From there he drove along the coast roads of New Jersey, and then inland to Washington. Commenting on his trip, he said:

"From the time we started east from Buffalo until we arrived here we have hardly been off a hard surfaced highway, and it is certainly a revelation to know so many miles may be traveled with such perfect comfort and such surety of road conditions as has been our experience. I am told that we are not yet thru with it, as we shall continue on this thru Maryland on our homeward trip. During this trip we have met many a westerner and several friends on tour, and each is enthusiastic in his praises; each is a convert to the type of road we have experienced and all of us are going back home with two fixed resolves; one is to repeat our trips next year, but more important than that will be the propaganda of education which we shall spread as to the value of the hard surfaced road out in our great prairie land. We have the wealth, but it has only been such experiences as ours that will teach the value of the highway that can be traveled regardless of weather, both as automobilists on pleasure bent and as raisers of foodstuffs that must be hauled to market regardless of weather conditions and with regard only to market conditions. We have all become converts and boosters for the hard surfaced road."

WATER WORKS *of* VALPARAISO, IND.

By E. L. Loomis, Superintendent Valparaiso Home Water Company.

This description of the plant and development of the water company serving the city of Valparaiso, Indiana, is of a nature not usually obtainable from operators of water plants owned by private corporations. It is what every plant operator should be willing to supply, and if all were equally free with their statements of conditions, methods and results there would be less complaint concerning private ownership of public utilities, because there would be more knowledge of the difficulties to be overcome and better appreciation of the efforts of the companies to overcome them. Of course, there are companies which could not afford to be as frank as Mr. Loomis is, but the majority of the privately owned plants would find it to their advantage to take the public into their confidence, at least as far as this paper does.



THE city of Valparaiso, Indiana, obtains the principal portion of its water supply from Flint Lake, the largest and lowest of a chain of six lakes situated three miles distant from the city. These lakes aggregate about one square mile in area, and owing to the fact that they are exclusively fed by the natural rainfall over a watershed about four square miles in extent, the water is of exceptional softness, and when filtered, it becomes of ideal quality, both for family and industrial uses.

Until five years ago, notwithstanding the constant pumpage during a period of twenty-five years, these lakes showed practically no decrease in supply. On account of the light rainfall which was far below normal at Valparaiso for a few years, however, the water line of the lakes steadily receded, thus making a system of wells necessary as an additional source of supply, temporarily at least. Altho resulting in much harder water than that obtained from the lake, and therefore, not so desirable, the wells were sunk thru a depth of fifty feet of fine water-bearing sand, where it is believed an inexhaustible supply of clear, cold and healthful water has been found.

In 1885 the original plant was constructed by the Michigan Pipe Company, of Bay City, Mich. In 1904 it was purchased and has since been owned and operated by the Valparaiso Home Water Company, a corporation composed of citizens of Valparaiso.

Since taking over the property, the local company has practically rebuilt and equipped anew the entire power plant, including boilers, coal storage room, wells, electric lighting system, laboratory, new pumping engine and a complete concrete filtration plant. Much of the old equipment, however, has been repaired and left in position for reserve or emergency use.

The main superstructure and wings of the plant are of brick and concrete, being of ample dimensions and suitably divided into boiler, engine, filter, machinery, laboratory and chemical rooms. The concrete coal supply room has storage capacity for 750 tons.

Pumping direct from the plant to the city, the plant has a total daily capacity of 4,500,000 gallons, the following pumps being available for this service:

1. Gaskell-Holly, horizontal, crank and fly-wheel, non-compound, condensing, poppet valve gear, inside center-packed plunger, with attached air and feed pumps. Size, 20 by 12 by 18 inches. Capacity, 1,500,000 daily. Installed 1885.

2. Dean of Holyoke, duplex, plunger and ring type. Size, 16 by 10¾ by 10 inches. Capacity, 1,000,000 daily. Installed in 1902 for emergency use only and not for regular duty.

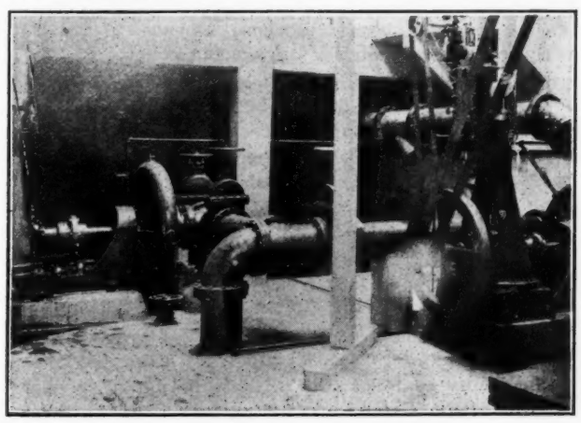
3. Canton-Hughes, Wooster, Ohio, cross-compound, crank and fly-wheel, Meyer gear, outside center-packed, with condenser in suction and attached air and feed pumps. Size, 10¾ by 19 by 9½ by 18 inches. Capacity, 2,000,000 gallons daily. Installed 1913. Guaranteed duty eighty million foot pounds per thousand pounds dry steam at one-half capacity.

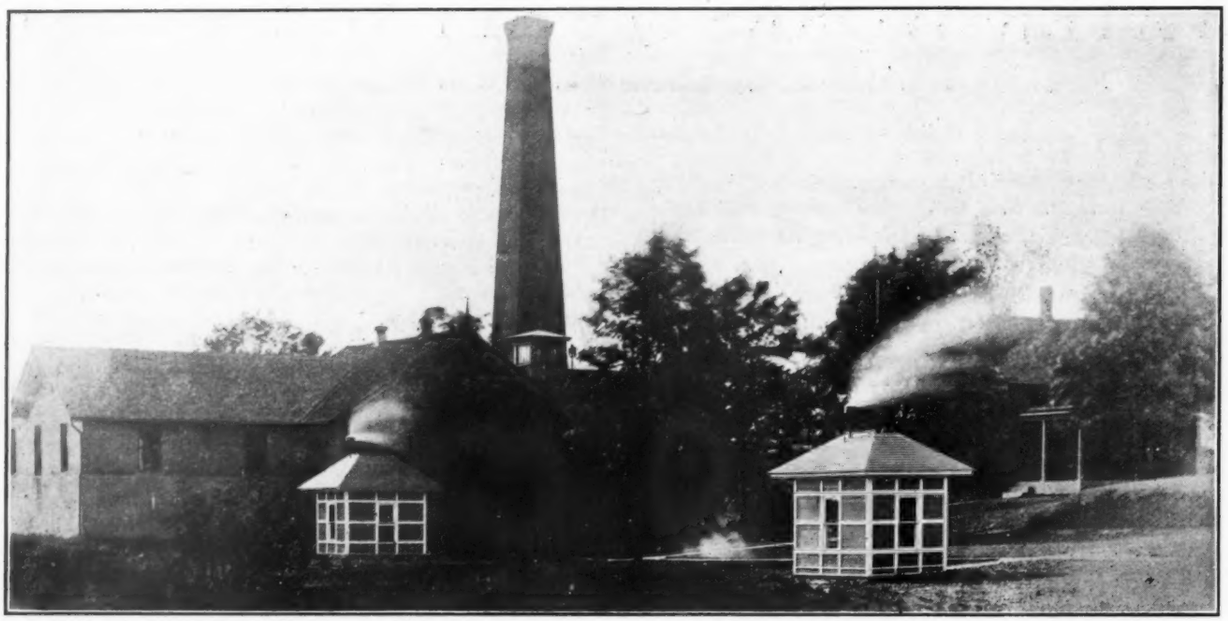
Water gravitates thru two 12-inch pipe lines from the lake to the intake well. It is then lifted to the sedimentation basin of the filter plant by a 6-inch Lawrence "Vortex" centrifugal engine-driven pump. A No. 8 Lawrence "Vortex" centrifugal engine-driven pump is used for washing the filter beds. These two Lawrence machines are inter-connected so that the wash pump may also be used for pumping raw water, and that the raw-water pump may also be used for emptying the sedimentation basin.

Two 10 by 36-inch and one 12 by 36-inch A. D. Cook deep well pumps, combined capacity 1,120,000 gallons daily, lift the water from the wells when they are in use, and deliver the same either into the intake well or into the clear-well reservoir where it may be mixed with the filtered water from the lake before being pumped to the city.

During the outing season each summer a large number

CENTRIFUGAL PUMPS *for lifting water to mixing chamber, to flow thence thru coagulating basin and filters to the main pumps; and for pumping water to wash the filters.*





THE PLANT *of the Valparaiso Home Water Company. Pumping and filter station in background. Small pump houses over deep wells in foreground. Residence of employe at the right.*

of cottages about the shores of the lakes are occupied by persons from Valparaiso, Chicago and other cities, the natural scenery and forests surrounding the lakes affording a most inviting spot to those seeking outdoor pastime and recreation. An interurban street railway line passes the shores of the lakes, connecting the same direct with the cities of Gary, Hammond, Laporte, Chesterton and Valparaiso. Thus, the summer population is very rapidly increasing from year to year. With a number of good hotels, dancing pavilions, the various amusements, all in addition to the fascination of good fishing and fine bathing beaches, it is small wonder that there are always hundreds, and many times, upon special occasions, several thousand persons present and participating in these enjoyments. Naturally, the drainage from ground about these places is toward the lake, and while no bad effect has thus far been observed, the possibility for contamination of the water supply from this source is considerable, to say the least. In addition to the possibilities of contamination from drainage, there has always been more or less complaint from water consumers during a portion of each summer because of an algae growth in the lakes, with the resultant odors emanating from the decomposition of the same.

On account of these conditions, unusual to most water plants, and acting upon the advice and counsel of the State Board of Health, as well as experts whose aid was sought in order to overcome these difficulties, the Home Water Company installed a complete concrete mechanical filtration plant, a detailed report of which would here seem to be worth while.

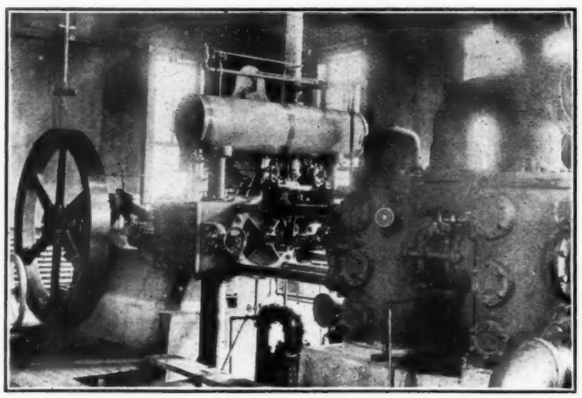
In designing this plant provision was made for the aeration of the water during the troublesome algae period. The general design was intended to minimize as much as possible the labor required in operation and at the same time to install a plant that would be low in first cost and also give satisfactory efficiency.

The plant consists of three concrete filter units, having a total capacity of 2,000,000 gallons per day. Two of these units are fully equipped, the third to be placed in operation as the growth in water consumption may require. Below the filters is located the clear water basin of approximately 100,000 gallons capacity. Immediately adjoining the filter building is the concrete sedimentation basin which, with a capacity of 135,000 gallons, is partially inclosed and partially exposed. An ell or wing of the building is carried over one end of this basin, and in this wing are installed the coagulating apparatus and storage room for coagulants.

From the intake well the water is pumped in its raw state into the mixing chamber, where, discharging over a funnel about four feet above the water line and dropping freely thru the air, it has an opportunity for aeration in the fall and the carrying down of the air into the mixing chamber produces the desired result in eliminating the odors.

Whenever more air becomes necessary for oxidation than is available in this way, however, there is provided a small air-compressor and storage tank. This is arranged to pump air thru a perforated grill of brass pipe that is placed across and near the bottom of the inlet chamber. The water passes out of the inlet chamber at the bottom thru a sluice valve into a perforated conduit which extends across the end of the basin, passing around the baffle wall dividing the basin and

NEW CANTON-HUGHES PUMP *of 2,000,000 gallons capacity, one of three used to pump filtered water by direct pressure thru the distribution system to consumers.*



under the building, coming back to the outlet overflow box, which is connected to a concrete conduit which conveys the water to the filters. This outlet box also is connected to the inlet chamber by a sluice gate, so that when the necessity arises for cleaning out the coagulant the filter plant can be continued in operation by by-passing the water directly to the filters from the inlet chamber.

In the center of the filter is a double valve which is used for admitting the treated water to the filter beds and, in the process of washing, allowing the wash water to pass from the beds thru a connecting conduit into the sewer which is formed in the supporting wall of the front of the filter.

Thus, the only pipe line in the gallery is the wash water line for conveying the water under pressure from the wash pump to wash the filters. These filters were installed without the use of any agitating apparatus, it being considered that because of the character of the water to be treated, satisfactory results would be obtained with the use of water alone for washing. Experience, however, taught the contrary to be true, and a complete air-wash system has been installed. Passing thru a conduit and admitted to the filter beds, the water then passes or filters thru the sand beds and is received into the clear-well beneath the filters, whence the high-service pumps deliver it into the city mains.

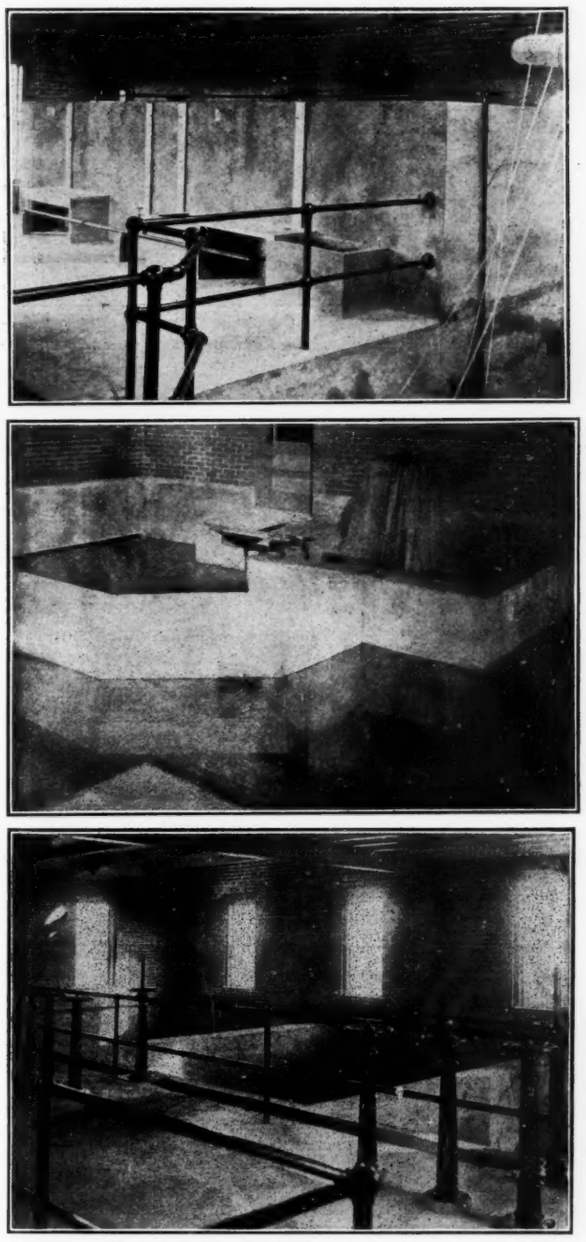
Altho the plant is equipped for the use of lime, iron or alum, the coagulant thus far used has been exclusively alum. In all, there are four concrete solution tanks, which are equipped with mechanical agitators. These tanks are about six feet square and five feet deep. The discharge from them is into the concrete orifice box, the solution passing thru finely graduated orfices and being carried from there to the point of application by gravity.

The low service pumps are connected up so that they can be used interchangeably, thus accomplishing practically the same result as a double installation for service in case of emergency.

After a visit to this plant and having made many careful analyses of the filtered and raw water, Dr. H. E. Barnard, state food and drug commissioner and chemist, once said: "When in efficient operation, this method of treatment will remove all suspended matter, abstract practically all color due to organic decomposition and will remove 98 per cent. of the bacteria present. Such purification renders the ordinary water quite safe and potable, and water of the type obtained from Flint Lake should be of unquestionable quality. It is greatly to be regretted that water of such ideal characteristics for drinking and domestic purposes as that normally supplied by Flint Lake should be subject to pollution. But as this unfortunate condition cannot be relieved, proper filtration must be relied upon to protect the health of the community. This can be obtained with the system installed."

The distributing system of the plant consists of over twenty-two miles of "Michigan" improved water pipe, ranging in sizes from 4 to 12 inches, as follows: Four-inch pipe, 74,446 feet; 6-inch pipe, 23,453 feet; 8-inch pipe, 718 feet; 10-inch pipe, 2,475 feet; 12-inch pipe, 16,177 feet. There are 145 hydrants on the lines.

Altho much of this pipe has been installed twenty-eight years, during all of which time it has been under constant direct pressures ranging from 40 to 125 pounds, it has thus far shown but slight signs of deterioration, and it is confidently believed to be good for many years' service yet to come. The system is free from leakage and the annual maintenance cost is meager. In fact, so satisfactory has experience demonstrated this pipe to be that it is used exclusively in all the new installation work. When properly made and installed, if kept constantly filled with water and free from air, the life of this pipe is apparently interminable. Moreover, on account of its high economy in construction, as well as for its sanitary service in keeping the water cool, fresh and pure, it has proven itself to be especially desirable. The entire distributing system at Valparaiso is made to withstand a pressure of 200 pounds.



PURIFICATION PROCESS *of Valparaiso Home Water Company.* ABOVE, *chemical solution tanks;* CENTER, *portion of coagulating basin;* BELOW, *portion of filter beds, showing part of operating gallery.*

Since the local management began the operation of the plant in 1904, improvements to the plant equipment and extensions to the distributing system have been made at a total cost of $70,000.00. Not only have these improvements been made and paid for out of the earnings of the plant, but the bonded debt has been reduced to the extent of $35,000.00 as well, leaving at the present time outstanding a bonded debt of only $55,000.00, with no floating indebtedness of any kind whatsoever against the plant.

OFFICE *of Valparaiso Home Water Company, showing Superintendent Loomis at his desk, accessible imdiately to all callers.*

The difference in cost of pumping under the various conditions is indicated for the Holly-Gaskell pump by the average cost of pumping direct from the wells thru the distribution being 1.637 cents per 1,000 gallons; pumping thru the filters, 2.231 cents per 1,000 gallons, and pumping from the wells, 2.2 cents per 1,000 gallons. The Canton-Hughes pump gives somewhat lower cost.

During one year over 300,000,000 gallons of water are pumped and delivered to the citizens of Valparaiso. The total cash receipts for this period are over $30,000, and the total operating expenses are about $17,000.

The business affairs of the company are directed by a board of five directors, all of whom are local business men. The president of the company is Oliver P. Kinsey, vice president of Valparaiso University. Other directors are John W. Sieb, Stephen L. Finney, Schuyler C. Billings and Melvin J. Stinchfield. The active management of the business devolves upon the superintendent, E. L. Loomis. The power and filtration plants are in charge of J. F. Bradley, chief engineer and bacteriologist.

It is the constant aim of the company to maintain its plant in the highest state of efficiency and to give its patrons the very best service possible.

THE WALL OF THE CITY OF LONDON

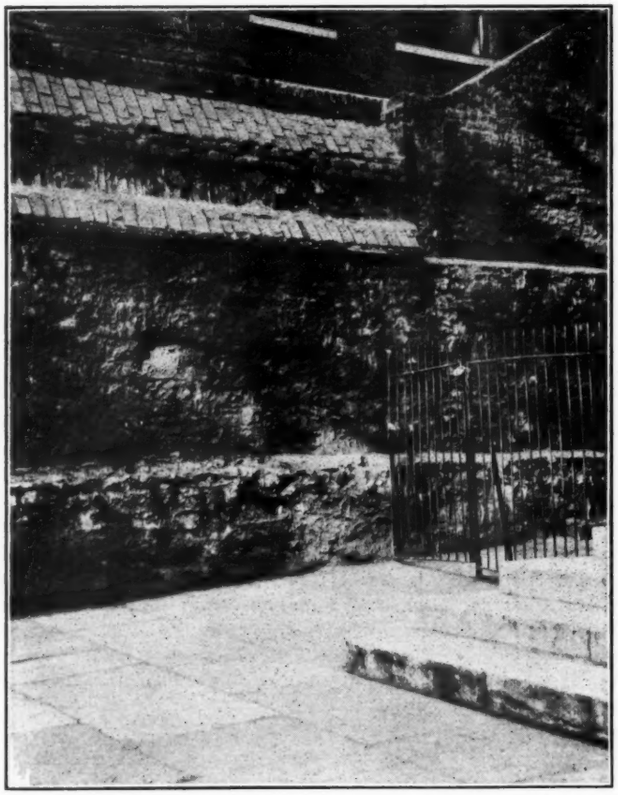
Though Paris has well-preserved fortifications which completely surround the older portion of the city, London's walls disappeared long ago, except for a half dozen fragments which are preserved as examples of Roman and medieval construction.

An interesting fragment of the original Roman work is found in the basement of a modern business block near Tower Green. Regular rows of Kentish ragstone alternate with flat, red tiles, and both are laid in cement which is harder than either the stone or brick. This old wall forms the rear foundation of the modern structure.

Another section of Roman wall was recently unearthed in the courtyard of the new general postoffice. It is viewed by descending into a crypt built to contain the relic of antiquity.

Sections of rebuilt Roman construction, with the red tiles irregularly mingled with courses of stone, are to be seen in the graveyard of St. Giles, Cripplegate, in what is said to have been a bastion of the old wall, and in two fragments, one of them in the churchyard of St. Alphage, and another at the rear of St. Botolph, Aldgate.

Portions of the Tower of London were erected on the wall which, extending around the square mile comprising the earlier city, defines what is still known as the City of London, as distinguished from the great metropolitan area.



Station Entrances on Boston Subways

By W. B. Conant, Concord, Mass.

Too often the designing of subway stations and similar openings upon the street has been a matter of routine, and it is a pleasure to read a description of a number of designs made with the express purpose of fitting the structures to their surroundings as nearly as possible. The designs here shown are no two alike and show the attempt at conformity with adjoining existing structures. The structures themselves show this even better than these photographs, which are naturally taken in such manner as to emphasize the subway entrances, whereas on the ground the effect is to make them relatively inconspicuous, tho sufficiently evident to advertise their presence to those needing to use them.

IN the construction of the new Boylston street subway, in Boston, Mass., the transit commissioners expended much care on the superstructures of the entrances and exits of the stations. The subway pierces the high-class Back Bay section of the city, has two stations between Boylston and Tremont streets and its outlet at Beacon street and Commonwealth avenue. The stations are Copley and Massachusetts, at the square and avenue respectively.

At Copley Square is a single eastbound station superstructure (Fig. 1) which provides both entrance and exit. It is of elaborate and tasteful design and stands near the north wall of the Boston Public Library. The station structure is composed of cast iron and wired glass, and harmonizes with the architecture of the library building. Except for the direction signs on either side, of white on blue glass background, and a wooden sign which protrudes from the center of the hood, the structure might readily be taken for the entrance to a conservatory or other fine municipal building. The cost of the above-ground erection was about $10,000.

The westbound Copley station is provided with an entrance and exit (Fig. 2), one on either side of Dartmouth street, penetrating the broad sidewalk, which has been widened somewhat to give room. For each of these openings a low hood is provided, which covers one-half of a granite base 4.5 feet high above the sidewalk. The arching hood is of concrete with a bronze and copper canopy over it. This type of entrance-exit offers little obstruction to the view, being low and relatively inconspicuous, and is least objectionable to nearby property holders, which are here, on one side, a church, and on the other, stores and offices.

The cost of the two substantial structures serving the westbound station was between $5,000 and $6,000 each, the polished stone and bronze castings representing considerable skill besides value of materials.

The Massachusetts avenue station (Fig. 3) comprises a stairway entrance and exit, and a waiting room on the street level for transferring passengers. A concrete building about 35 by 30 feet is erected above the tunnel on property that the Transit Commission acquired, demolishing the large building that stood on the lot. The entrance structure was left in the rough, so far as its exterior walls are concerned, it being the commission's purpose to sell the ground area surrounding the building, and eventually a business block will probably be erected around and enclosing the station.

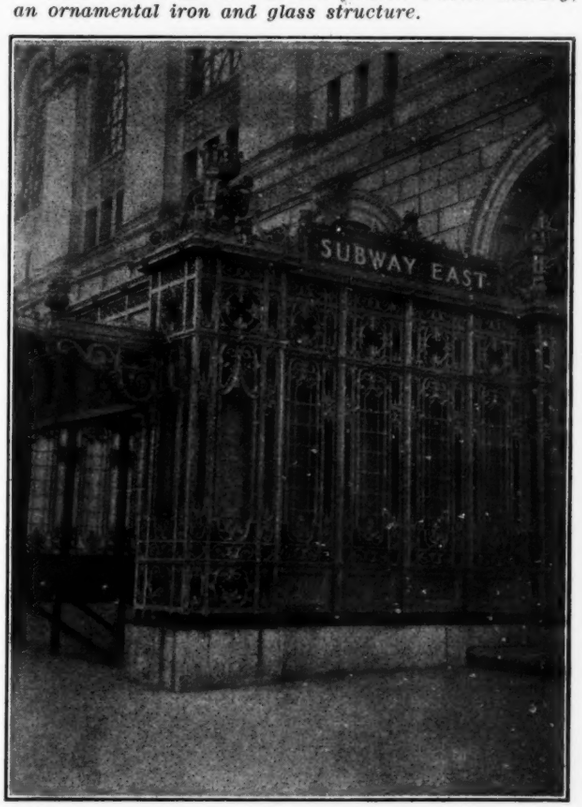
An earlier type of subway station, built at the time of the first subway construction in Boston, is of granite, with wired glass roof set in copper frame and sufficiently high to house the whole stairway and lobby area and also provide sign space over the entrances and exits. Of these structures there are eight on Boston Common—four at Park and four at Boylton street—and one each at Adams and at Scollay Squares.

The Common station superstructures have 15-foot stairways. The wall windows are covered externally with a bronze grill work, which gives the effect of small, triangular glass panes. The Scollay Square structure has high, arched windows, and the tile roof contracts to a square tower with a clock on each face. The Haymarket Square station is of steel, with low, overhanging roof.

The earlier structures of this general type were practicable where ample space was available, as on the Common. Their durability in the center of the squares mentioned is open to question, particularly with the increase in street traffic since they were erected.

A third underground system in Boston is the Washington street tunnel. Here the prevailing type of entrances-exits is thru the street floor and basement of business buildings. Such use was made at Summer and Winter streets, at Boylston and Essex, and at Milk street. The State street entrance

SUBWAY STATION *at the Boston Public Library, an ornamental iron and glass structure.*



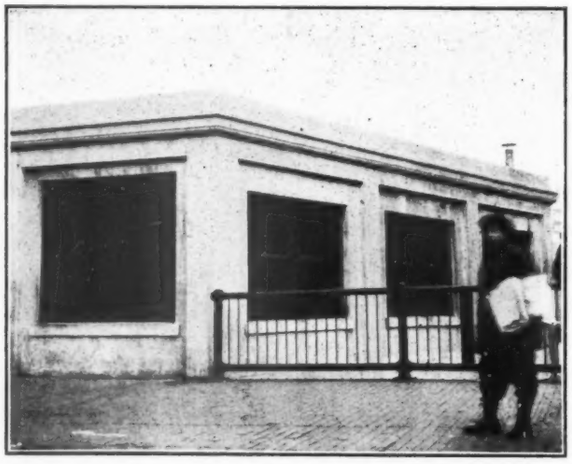
ENTRANCE AND EXIT *to and from the Dartmouth street subway station. An ornament brass and copper hood with a granite base.*

is thru the lower floor of the old State House, and at Milk street an exit and entrance are provided by two concrete hoods in an area between the Old South church and a nearby block. These coverings are relatively inconspicuous, obstruct no valuable light, and at the same time form adequate protection from the weather.

The East Boston tunnel is provided with a two-story structure at State street and Atlantic avenue. The tunnel at this point is far below the street level, as the harbor under-pass is approached, and elevators are installed to convey passengers from the station platform to the street and to the level of the elevated railway above. A small emergency exit is located a few yards west of the main structure and is of the typical stone and pitched roof construction common to Boston's earlier building.

The Park street station's stairways are supplemented by escalators, which provide an outlet for the Cambridge tunnel. One, of the Reno or cleat type, comes to the sidewalk opposite the foot of Park street, and one, of the Seeberger or stair type, nearly opposite St. Paul's Cathedral (Fig. 4). Each is provided with a rectangular glass and steel hood, with sloping

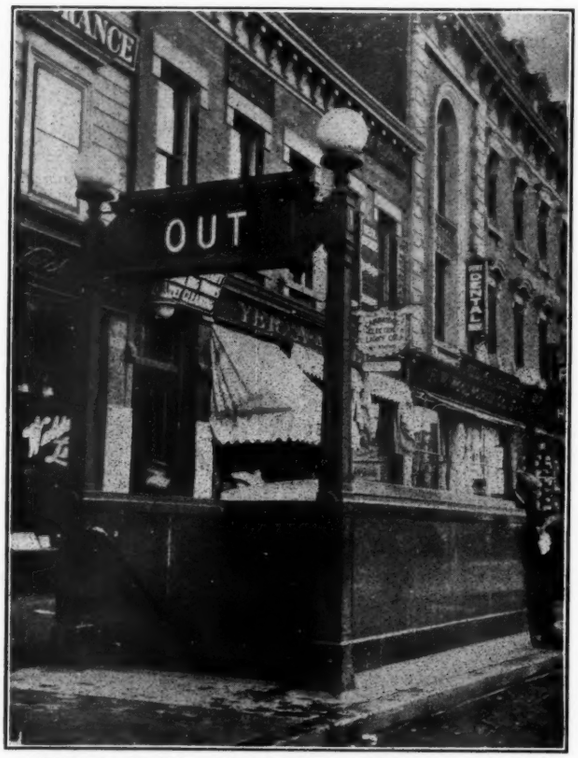
MASSACHUSETTS STATION ENTRANCE *to Boylston street subway, arranged for future commercial use of the premises, it being possible to erect a building around and over it.*



copper roof, and affords a complete protection to the mechanisms from the action of the weather.

In the Dorchester tunnel, now under construction and due to be completed in one and a half to two years, there will be four stations—one at Washington street, where the exits and entrances will be thru private property; at Dewey Square, where the station will be reached directly from the street; a station near Broadway and Dorchester avenue; and one at or near Andrew Square, the present terminal. Both the latter structures are yet to be determined upon.

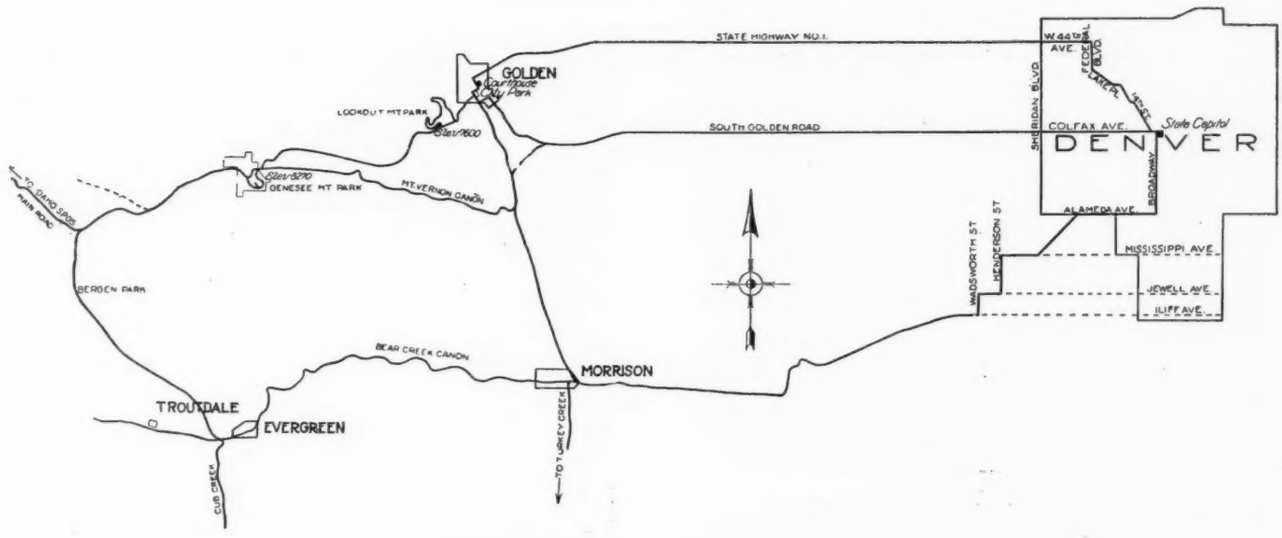
The Transit Commission's engineers point out the practical advantages of the wholly-covered structures, in that they afford more complete protection from rain and snow and thereby minimizes the danger of accident particularly in freeing weather. On the other hand, in positions in front of business houses, where light and air are important considerations, the low, half-covered structure is demanded, and is the prevailing type under those conditions, in Boston and Cambridge. The



PLAIN GLASS AND STEEL HOOD *in a business street over the escalator at the Park street station, nearly opposite St. Paul's Cathedral.*

means of access thru private property have obvious disadvantages in that less permanence is assured, such property being liable to reconstruction. However, where public area is lacking, either in the street or sidewalk space, it is inevitable.

The Boston Transit Commission consists of five members, of whom the mayor appoints three and the governor of Massachusetts two. The bonds for construction purposes are issued by the city of Boston and the construction is done under contract, on plans and under the supervision of the commission's engineer. The existing tunnels and subways are leased to the Boston Elevated Railway at a fraction of a per cent. above the yield of the bonds. The Cambridge tunnel was constructed by, and is the property of, the Boston Elevated Railway Company.



Connecting Roads to Mountain Parks

OF DENVER, COLORADO.

By Otto B. Thum, Denver, Colo.

The wonderful mountain park and road system of Denver, Colorado, is indicated in the west section of the above map and the roads connecting it with the city are shown. The county and state authorities are paving these connecting roads so that Denver and the many tourists visiting the city can have the full benefit of the natural and artificial beauties of the district. This article describes some of the work in progress and completed, and the pictures tell the story of the methods of construction used.

WHILE the Denver Park Department was developing the Mountain Parks System and constructing permanent roads throut, they did not lose sight of the fact that the parks and roads would be useless until something was done to overcome the conditions of the approaches. (Fig. 1.)

About four years ago the commissioners of Arapahoe county had a mile of concrete road built by a contractor, who knew little or nothing about that kind of road construction. This road was built to overcome a bad soft spot on the main road from Denver to Littleton, the county seat of Arapahoe county. The road has proved to be a failure, as a smooth riding highway, and is now practically worn out, even tho the commissioners have spent a great deal of money in up-keep. This piece of road on the Littleton course has always been an eye-sore and bugbear to the cement companies in Denver, they claiming that a cement road properly built would wear for years, with little or no up-keep.

In order to prove this statement, the companies submitted the proposition that if the Denver Park Department would give them $7,000,000, and do the grading, they would guarantee to construct a mile of concrete road, on the Morrison road, beginning at, approximately, one mile south of Alameda avenue, on Sheridan boulevard, and running one mile west. The companies further guaranteed to build the road in first-class condition, in every particular, under the supervision of a cement expert, the width to be 16 feet.

After several conferences between the officers of the cement companies and the city, it was decided to alter the specifications to read as follows:

One-course work and one consistency thruout.

The mixture to consist of 1 part portland cement to 1½ parts sand and 3 parts gravel.

The thickness to be 7½ inches in center and 5 inches on the side, making a slope of 2½ inches from the crown.

The roadway to be 18 feet wide, with ¼-inch joints, placed every 25 feet. These joints to consist of a trussed concrete steel bar, made by the Trussed Concrete Steel Company.

The filler for the joints to be elastite, made by the Philip Carey Company.

The city to pay $7,500, instead of $7,000.

Immediately after the signing of the above specification, June 2, 1915, the park department made a new survey of the road and started to grade and drain, according to their agreement, and as soon as practical the cement companies started on the road building. The cement expert in charge turned in the following report after completion:

THE ROADS BEFORE IMPROVEMENT.

PHOTO BY WISWALL, DENVER

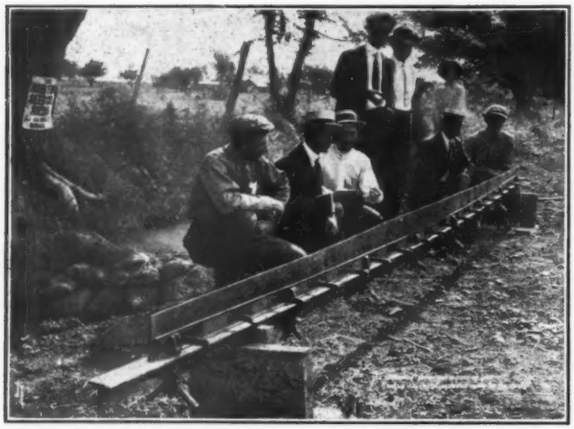
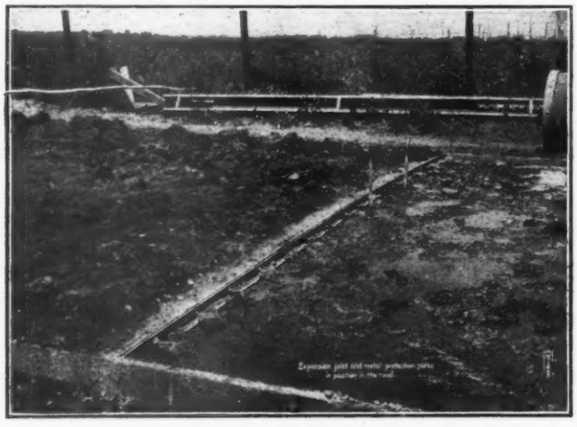


PHOTO BY WISWALL, DENVER



EXPANSION JOINT. ABOVE, *the joint ready in its construction frame for placing. It is in reverse position, with the steel protecting plates below and the asphalted felt expansion cushion projecting up.* BELOW, *the joint in place, with concrete slab laid on one side and anchoring projections ready for laying slab on right side.*

As soon as practical after the concrete was poured, the same was covered with burlap for a few hours to protect it from the sun and wind. As soon as the concrete was sufficiently dry to justify it, the road was covered with dirt, this dirt was left on the road for thirty days, or until it was opened for traffic. The road was kept thoroly wet for two weeks after it had been poured. The photographs tell the story of the construction.

While this road is not yet a year old, it has upset the general opinion that scientifically constructed and maintained roads are only for the wealthier communities. While this mile of roadway cost $13,098.23, there has not been one cent spent on upkeep and all indications are that there will be none spent this year or next.

Statistics show that the average country road which is not a thorofare requires an average yearly expenditure of $500 per mile to keep it in fairly good condition part of the time, protracted wet seasons making it practically useless just at a time when those who use the road have time to go and come.

The unit costs of this mile of concrete road are as follows:

Cement cost—$1.79 per barrel, net, sacks extra, f. o. b. the job, which figures approximately 51 cents per square yard of pavement.

Sand cost—$1.40 per cubic yard, f. o. b. the job, which figures approximately 11 cents per square yard of pavement.

Gravel cost—$1.75 per cubic yard, f. o. b. the job, which figures approximately 27 cents per square yard of pavement.

Trussed concrete steel plate cost—$2.49 per joint, f. o. b. the job, the road being 18 feet wide and two plates at each joint, which figures approximately 5 cents per square yard of pavement.

Elastite—Used as a filler for the expansion joints, cost 57 cents per joint, which figures approximately 1 cent per square yard of pavement.

Laying cost—With all materials furnished at the job, was 18 cents per square yard.

LAYING THE CONCRETE. ABOVE, *the distribution of materials and transfer to mixer;* CENTER, *the receiving end of the mixer;* BELOW, *the discharge end of the mixer. Note wooden forms along sides of road.*

PHOTO BY WISWALL, DENVER

PHOTO BY WISWALL, DENVER

COMPLETED CONCRETE ROAD *covered with earth as promptly as possible after laying concrete and kept sprinkled until concrete is completely cured.*

Haul—The average haul for all materials was 3½ miles.

Total cost—Exclusive of grading and drainage, including superintendence, inspection and all incidentals not mentioned above, was $13,098.23. This figures $1.23 per square yard of pavement.

Engineers hold different opinions as to the necessity of an 18-foot roadbed, stating that, in their idea, 16 feet is plenty wide, but this article deals with only what has been done, and not what people think.

While the above work was going on, the department, with small financial aid from Jefferson county thru which the Morrison road runs, was busy widening and surfacing the balance of the 17 miles between Denver and Morrison.

The North Golden or State Highway No. 1, runs thru a higher and more solid formation than either the Morrison or South Golden road. For this reason, the park department did what little work was necessary, such as widening out and surfacing a few places. At the same time they built the first Mountain Parks System roads, thereby giving the tourist a good road to the system as soon as the mountain roads were opened.

The South Golden road, which in time will be the main thorofare to the mountain parks, because it is a few miles shorter and runs thru a beautiful agricultural section, has not had any work whatsoever done on it. The reason for this is that the city is building a new viaduct over the railroad tracks, Platte river and Cherry creek. When this is completed the park department will push work on the South Golden road.

The park engineers have under consideration for this road a 9-foot concrete road on one side of the roadway and a 9-foot disintegrated granite road on the other. Differences of opinion again arise as to the feasibility of this, as some claim that the junction of the two would be too noticeable, that when a vehicle turned onto the concrete the wheels would tear the granite away.

The main idea of the department is to construct this road half and half so that the entire course may be built at approximately $5,000 a mile, and in the future, if it so desires, it may widen the road at the same cost, thereby not throwing a heavy cost upon the department all at once.

THE COMPLETED ROAD *is only less scenic and wonderful in beauty than the mountain park roads themselves.*

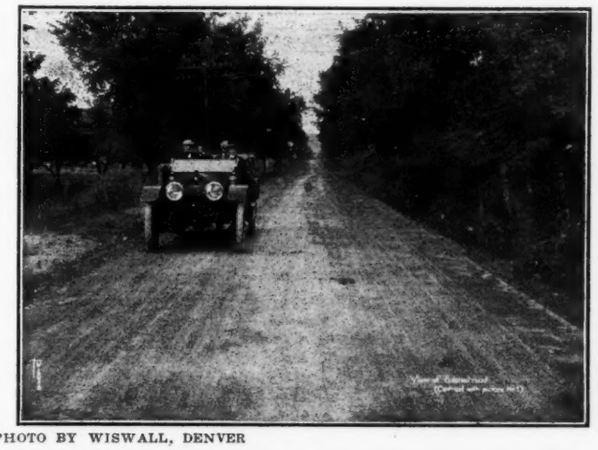
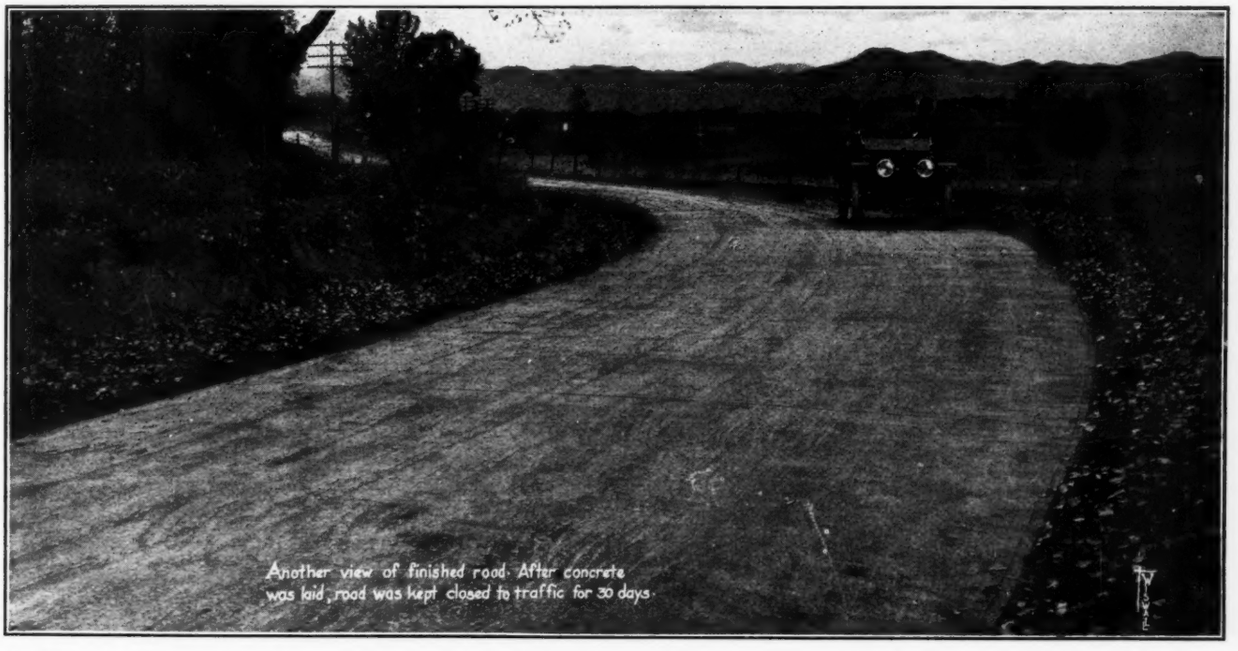


PHOTO BY WISWALL, DENVER



QUESTION DEPARTMENT

Makers of Garbage Trucks, Wagons and Carts

Will you please inform me who makes garbage trucks or handles same? T., ————, Mo.

Sanitary garbage carts for one or two horses are made by George H. Holzbog & Bro., Jeffersonville, Ind.

Studebaker Corporation, South Bend, Ind., are makers of garbage wagons and of motor trucks.

The most satisfactory way of operating garbage collection with automobiles seems to be to collect the garbage in wagons or carts hauled by horses; these trucks, when full, being turned over as trailers to an automobile tractor, which hauls them rapidly to the dump and brings back the clean wagons to exchange for those that have been filled.

The Knox Motors Company make the Knox tractor, which is adapted to this use. The wagons made by the firms named above can be fitted for use as trailers in this system.

Steel garbage wagon tanks are made by the Buckeye Boiler Company, Dayton, Ohio, and the Sims Company, Erie, Pa., which are also applicable.

The Troy Wagon Works Company, Troy, Ohio, make automobile truck trailers, which can be fitted with the tanks.

Any motor truck or truck trailer can be fitted with the steel garbage wagon tanks, regulations in many cities requiring that the tanks have tight covers, steel sectional lids in some cases and canvas in others.

Several articles descriptive of garbage collecting devices, wagons and trucks will be found in back numbers of MUNICIPAL ENGINEERING, lists of which will be found in vol. xlvii, p. 292, and vol. xlii, p. 252.

Directory of Cement Manufacturers

Will you kindly advise me if you publish a directory of the cement manufacturers of the United States and Canada, with descriptions of plants and processes, and the price of same.

Also if I could get a list of cement plants in the United States and Canada using marl for a raw material and a list of those plants using the wet or semi-wet process on dry raw material.

Also if you could supply me with a detailed description or write-up of the plant of the Sandusky Portland Cement Company, at Sandusky, Ohio.

K., Calgary, Alberta.

The Directory of American Cement Industries has not been published since 1909. A list of cement manufacturers is published each year by *The Cement Era*, of Chicago, for $1, which probably gives the information desired as to users of marl and the wet processes of making cement. Up-to-date descriptions of the Sandusky Portland Cement Company's plants are not at hand. Information concerning them can probably be obtained in considerable detail by writing to the company.

Garbage Collection by the City

We have a city of about four thousand people and the sanitary conditions are not very satisfactory. We want a model to go by in framing an ordinance for the handling of the garbage from the residences and business places. This refers both to the wastes from the dry closets and the solid wastes that accumulate around any place in the course of time, such as trash and the like. We are not able to agree whether or not we should attempt to haul all this stuff away for the people or try to make each attend to his own part of it. I advocate the city's doing the work, but there is much opposition to me in the city council.

S., ————, Fla.

The best results are obtained when the city collects and disposes of the garbage, if the work is put in charge of a competent department, which has adequate understanding of the necessity of sanitary methods and power enough to require their use. Next best is the letting of a contract for the collection under rigid specifications, requiring sanitary methods and complete removal. If the city pays the bill out of the treasury, the method which will bring the best results under local conditions should be chosen.

If the city cannot pay the bill, the collection should be made preferably by the city and a schedule of charges for removal of garbage and refuse should be prepared, which householders are required to pay. The collection of the garbage may be let by contract under these fees, but there will probably be more friction between the contractor and the householders than between the city and the householders, especially as regards the required payments.

An excellent form of ordinance, where the city collects the garbage and charges fees fixed by a schedule, will be found in MUNICIPAL ENGINEERING, vol. xlvii, p. 41, with some account of the success of the system.

Life and Maintenance Cost of Asphalt and Brick Pavements

We are desirous of obtaining information relative to a comparison between the costs of sheet asphalt and brick pavements.

We are especially interested in the comparison of maintenance costs after the pavement has passed the contractors guarantee period. Also comparative life of same.

If you can give us any data on the above we assure you it will be greatly appreciated.

W. C. Dickey, City Engineer, Conneaut, O.

A direct reply cannot be made to this question, either as to cost of construction or cost of maintenance.

Brick pavements are not in use in some eastern cities because their cost, due to the absence of good paving brick within a reasonable distance, is too high. The same is true

of asphalt in some western cities. In Ohio, undoubtedly, the cost of good brick pavements is materially less than that of good asphalt pavements. The prices given from month to month in the department of Contracting News in MUNICIPAL ENGINEERING show this. The exact difference is determined by the local conditions.

As to durability and cost of maintenance the answers must be equally indefinite if made in a general way, and to be of much value must be made after a careful study of the local conditions.

The maintenance of a poor brick street may well be more expensive than that of a good asphalt street, and its life shorter, but the statement may be reversed.

The city of Buffalo has kept careful records for some years of the life of pavements and the cost of repairs and the annual reports give these results. They are for Buffalo conditions and cannot be applied directly to any other case. Possibly individual streets could be selected that would be comparable with any particular street in another locality, but averages are only to be applied in the most general manner. With this warning, the following figures are given as taken from the latest report of the Bureau of Engineering of the Buffalo Department of Public Works. It should also be noted that the city has over 4,000,000 square yards of asphalt pavement in use and only about 530,000 square yards of brick.

Costs are hardly applicable in other cities because both asphalt and brick pavements are laid under 10-year guaranties, which increases prices materially, the average increase in prices for brick pavements being about 15 cents per square yard more for 10-year guaranty than for 5-year. Some other change operated on asphalt pavements at the time the guaranty period was extended, which caused a very great reduction in price, fully one-third.

As to durability, asphalt pavements laid in 1898 and subsequent years are still in use practically complete. Pavements laid prior to 1898 have had greater or less amounts of replacement, and average age of pavements laid each year varies from 14 years for those laid in 1878 to 33 years for those laid in 1881, the latter being still in use and adding to its average life. The average lives given in the table from which these figures are taken are not yet complete, as a large majority of the streets are still in use and adding daily to the average lives.

The same statement can be made even more emphatically in the case of brick pavements, as they are still all in use, the first having been laid in 1889, and only about 1,200 square yards having been taken up on account of street widening or construction of new street-car line.

As to annual cost of repairs after guaranties have expired, the cost of repair of asphalt streets averaged on the total area of asphalt streets, varied from 1.62 cents per square yard in 1902-3 to 8.27 cents in 1913-14, having been less than 5 cents each year up to 1907-8.

The repair of brick pavements, the oldest of which is 8 years younger than the oldest asphalt pavement in use, has varied from 1.51 cents a square yard, averaged on the total area of brick pavements in use, in 1909-10 to 6.49 cents in 1910-11, having been 4.98 cents in 1913-14.

Whether these comparisons are unfavorable to brick or to asphalt cannot be determined on the face of the statements. The area of brick pavements is but one-eighth that of the asphalt pavements and there is no information as to whether the pavements are among the best of their respective kinds or have been carelessly constructed or with inferior materials, or as to whether they have been properly selected and designed for the work expected of them.

Information on cost of construction and of maintenance of pavements may be found in MUNICIPAL ENGINEERING in many back volumes, among the latest being the following:

In St. Paul, Minn., vol. xlvii, p. 229, vol. xlv, p. 63; in Chicago, vol. xlvii, p. 184, vol. xliv, p. 542; in Buffalo, N. Y., vol. xlvi, pp. 57, 58; in Trenton, N. J., vol. xlvi, p. 102, vol. xliv, p. 246; in Baltimore, vol. xlvi, p. 2; in Detroit, vol. xlv, p. 435; in St. Louis, vol. xlv, p. 324; in Winnipeg, vol. xlv, p. 546; in Toledo, vol. xlv, p. 251; in Dayton, vol. xliv, pp. 127, 332; in Cincinnati, vol. xlii, p. 458; in various cities, vol. xlvii, p. 414, vol. xlv, p. 448, vol. xliv, pp. 387, 334; on country highways, vol. xlv, p. 60, vol. xliv, p. 106.

Books on Sewage Disposal

May I ask you to cite me the best work on the design of sewage disposal plants for small towns?

W., ——, Iowa.

If one may judge by the first two volumes of a series, the third volume of the work by Metcalf and Eddy on American Sewerage Practice, which will be devoted to sewage disposal, will be a full and accurate statement of the best in American practice under American conditions. Kinnicutt, Winslow and Pratt's "Sewage Disposal" ($3) is a general view of the whole field and does not go into the details of design and construction. Fuller's "Sewage Disposal" ($6) is a larger book, covering the whole field of American practice and the principles on which it is based and will be found most valuable by the engineer. Ogden and Cleveland's "Practical Methods of Sewage Disposal" treats of the details of methods, apparatus and construction and may be used to great advantage as a supplement in these regards to the preceding book.

Other books more or less devoted to particular methods of sewage disposal are Venable's "Methods and Devices for Bacterial Treatment of Sewage" ($3); Allen's "Sewage Sludge" ($2.50), covering Imhoff tank practice; Schmeitzner's "Clarification of Sewage" ($1.50).

Most of the books on sewage disposal are by English authors and their methods must usually be modified as to some details to fit them for American conditions. Some of the more prominent are Banoise's "The Purification of Sewage" ($3.50); Dibdin's "Purification of Sewage and Water" ($6.50); Raike's "The Design, Construction and Maintenance of Sewage Disposal Works" ($4); Watson's "Sewage Systems" ($4); Dunbar's "The Principles of Sewage Treatment" ($4.50); Kershaw's "Modern Methods of Sewage Purification" ($7.50); Moore and Silevik's "Sanitary Engineering," 2 vols. ($14).

Garbage and Refuse Disposal Methods

Garbage and refuse disposal methods and appliances are interesting me and I would like information as to those of most efficiency now in use.

Reader, ——, N. Y.

The two principal methods of garbage disposal are by reduction and by incineration. Refuse is usually incinerated. When garbage is incinerated it is preferable to mix the refuse and garbage together.

Incineration is performed in high-temperature and in low-temperature furnaces. Possibly the high-temperature furnace is the more sanitary and the operation more complete, but the cost, including plant and overhead charges, may be greater by this method.

Reduction of garbage seems to be profitable in the larger cities, but one or two small cities have been more or less successful with plants under private ownership.

There seems to be an idea that foreign plants are more efficient than American plants. Possibly this is because conditions are different.

Information about the higher-temperature destructors can be obtained from such firms as The Destructor Co., 111 Broadway, New York; J. B. Harris, 65 Life and Casualty Bldg., Nashville, Tenn.; Atkinson-Morse Destructor Co., 30 Church street, New York; Morse-Boulger Destructor Co., New York. Information about lower-temperature incinerators may be obtained of the Decarie Co., Minneapolis, Minn.; The Dixon Engineering Co., Toledo, O., and others. Information about reduction plants is available mainly from the municipal plants at Cleveland and Columbus, O., and will be later from the new plant at Akron, O.

There are a number of recent projects for disposing of garbage by chemical treatment, by maceration, by pulverizing, followed if necessary by drying, producing fertilizers or base for fertilizers. Some of these have been described in MUNICIPAL ENGINEERING. Some recent articles are given in the following list:

In vol. xlviii: Garbage Reduced to Fertilizer, p. 299; Making Fuel Out of Garbage, 304; Garbage and Refuse Collection and Disposal in St. Louis, Mo., 340; Disposal of Garbage and Refuse in Seattle, p. 118; Garbage Disposal for North Yakima.

In vol. xlvii: Street Cleaning and Refuse Disposal in Philadelphia, p. 19; Profitable Conversion of City Garbage, p. 25; Vancouver Garbage Collection and Disposal Ordinance and Methods, p. 41; The Harris Municipal Garbage Incinerator and Steam Generator, p. 72; Garbage Incinerators and Destructors, p. 114; Garbage Disposal by the Hirsh Chemical System, p. 131; Refuse Destructor at Clifton, Boro of Richmond, New York City, p. 207; Garbage Reduction Systems, p. 291; Plants Making Fertilizer from Garbage, p. 292; Methods of Collection and Disposal of Garbage, p. 292; Domestic Refuse Destructor, p. 413; Refuse Destructor at Savannah, Ga., p. 416.

Two or three of these articles give references to previous articles and classified lists of the same, including one on Mixed Method Garbage and Waste Disposal in vol. xlv, p. 25.

All the articles named above are descriptions of modern practice or of new methods of more or less value which have been tested or are seriously proposed for test.

Morse's "Collection and Disposal of Municipal Waste" ($5) was at the time of its publication, 1908, the most complete record of operations in the United States covered by its title. Parson's "Disposal of Municipal Refuse" ($2) is a statement of New York practice. Venable's "Garbage Crematories in America" ($2) gives a full list of patents and descriptions of the plants using them up to 1906. Goodrich's three or more books give English destructor practice with brief mentions of American work of similar nature.

Machinery and Methods for Street Cleaning

I would like information on the most efficient machinery and methods in use today in street cleaning.
T., New York.

The best place to get information on this subject is probably the exhibition of street cleaning apparatus and appliances, held by the New York City Department of Street Cleaning. Notice has just been received that the next exhibition will be held in the First Regiment Artillery Armory, 68th street and Broadway, New York, during the week of Monday, October 11, 1915.

A very successful exhibit was held in 1914, concerning which information can doubtless be obtained from Jos. R. Buchanan, director of the exhibition under J. T. Fetherston, Commissioner of Street Cleaning, Municipal Building, New York.

Soper's "Modern Methods of Street Cleaning" ($3) gives a brief account of methods in use in various foreign cities and compares them with the methods in use in New York at the time the book was issued.

Pending the street cleaning exhibition above referred to, much excellent information can be obtained from manufacturers of such apparatus. The application of the motor to street cleaning, and especially to street sprinkling, is one of the latest developments. Such information can be obtained from the following, among the many sources: General Motors Truck Co., Pontiac, Mich.; American Car Sprinkler Co., Worcester, Mass.; E. D. Etnyre & Co., Oregon, Ill.; Kissel Motor Car Co., Hartford, Wis.; Austin-Western Road Machinery Co., Chicago, Ill.; Studebaker, South Bend, Ind.; Kindling Machinery Co., Milwaukee, Wis.

The reports of W. H. Connell, in charge of the street department in Philadelphia, are sources of information of value regarding the methods in use in that city.

MUNICIPAL ENGINEERING has had many articles descriptive of improved methods which are being introduced in large numbers, and of the improved machinery which is so important a part of the new methods. Following are a few of the latest of such articles, all in vol. xlviii, many more being available in earlier volumes:

Comparative Cost of Street Sweeping and Sprinkling with Mules and with Motors, p. 305; Machine vs. Hand Sweeping, p. 317; How to Clean Streets, p. 322; Street Cleaning in New York, p. 46; Pueblo's New Street Sprinkler and Flusher, p. 71; Combination Street Sweeper and Sprinkler, p. 139; A Snow Plow for Street Use, p. 147; Bituminous Streets Damaged by Street Flushing, p. 195, which refers to a number of earlier articles on street cleaning methods and results; Dust Laying on Streets and Roads, p. 196; Motor Snow Plow and Sweeper, p. 201; Combined Street Sprinkler and Sweeper, p. 220.

Yardage of Pavement Base per Sack of Cement

I wish you would inform me as to the number of square yards of concrete base for asphaltic concrete top that one sack of cement should lay, the base being 5-in. thick.

Our specifications call for a mixture of 1 part by measure of portland cement, 2½ parts by measure of clean sharp sand and 5 parts by measure of broken stone.

What I want to know is, what would be a reasonable amount of concrete base laid according to this mixture, figured in square yards, and whether it would be possible to lay only 1.4 square yards to 1 sack of cement on the above basis.
M., ———, Iowa.

Tables of ingredients of concrete give the amount of cement required for broken stone concrete of proportions 1:2.5:5 as 1.07 to 1.13 barrels, according to the size of the barrel. If a sack of cement is assumed as a cubic foot and as one-fourth of a barrel, the number of sacks of cement required for a cubic yard of the concrete would be about 4.4. As a cubic yard of concrete will lay 7.2 square yards of concrete base 5 inches thick, one sack of cement will lay a little over 1.6 square yards, so that if in actual work 1.4 square yards are laid with one sack of cement, the concrete is a little richer than the average of the tables.

Whether this is the proper amount of cement is another question, as the tables are based on assumed proportions of voids in the stone and the sand, and for any particular kinds of sand and stone the voids should be determined by trial in order to be able to choose the proper proportions of cement and of mortar to fill those voids.

WORKERS IN THE FIELD

The Determination of Road Values

The Editor of MUNICIPAL ENGINEERING:

Sir—The country is and has been expending enormous amounts of money for roads and pavements. Some of this work has been wisely done, but there has also been a considerable amount of guessing in the matter of judgment as to the adaptation of the types of roads to the uses to which they are to be put.

If we are not to expend money foolishly in the future, one of the things that must be done in order that sound judgment may be exercised, is to provide proper cost accounting data that will give us correct and accurate information. States, cities and counties have no fundamental system upon which a correct cost accounting system can be based.

It is disclosed upon investigation that there are no methods of watching and determining the results of expenditures in road building. The lack of a system of cost accounting would not be permitted in any private business. A reckless, careless board of directors in any corporation would be voted out at the first annual meeting at which such information was not forthcoming for the stockholders. Why should the larger co-operative bodies of cities and states, who furnish money with a liberal hand, be deprived of the information that is so essential to future proper expenditures?

The following provision, the principles of which are applicable to every state in the Union, has been under consideration in the State of Ohio. Its purpose is to require by law the establishment of a cost accounting system by which this indiscriminate, indefinite and uncertain expenditure of money may be prevented.

SECTIONIZING THE HIGHWAYS.

THE IMPROVEMENT, MAINTENANCE AND REPAIRS BY DEFINITE SECTIONS AND THE COST ACCOUNTING THEREOF.

Section 1. The County Highway Superintendent, within two years from the taking effect of this act, shall, with the Township Trustees, whose duty it shall be to aid and assist, divide the roads of his county into section of not less than two miles each, which shall be designated numerically. He shall prepare a road map of each township showing the location of every road therein, with its numbered sections and length thereof. As the maps are completed, they shall be recorded in the office of the County Highway Superintendent in a book especially provided for such purpose. As soon as said maps are completed, certified copies thereof in manner and form as directed by the State Highway Engineer shall be filed in the office of the State Highway Engineer. Upon receipt of such maps showing the location of the roads of the several counties of the state by the Highway Engineer. he shall issue a public notice thereof in one weekly publication in each county of the state, naming a day upon which all legal proceedings with reference to the roads of Ohio shall be referred to and designated by their respective numbers of their respective townships and respective counties, namely:

Road , section No. , in Township , County of , State of Ohio. Thereafter all official proceedings, contracts, work of construction, improvement, maintenance and repair, and cost accounting thereof by all state, county and township officials shall be made to relate to the several sections as so named, numbered and recorded.

Sec. 2. After notice of the operation of the requirements of this act by the State Highway Engineer it shall be the duty of the County Highway Superintendent and the Township Trustees respectively to report and map, file and record in the County Highway Superintendent's record of roads any new road or change that may be brought about under the provisions of the law in such cases made and provided, and upon the same being made of record in the office of the County Highway Superintendent, he shall certify the same to the State Highway Engineer in such manner and form as may be directed by that officer.

Sec. 3. The State Highway Engineer, the County Road Superintendent and the Township Trustee, in the exercise of their official duties of improving, maintaining and repairing the roads under their respective jurisdiction, shall be required to keep a record which shall show the character of the improvement, its cost, the character of the maintenance of repair and cost which will disclose full information concerning the condition of each road section respectively—its improvement, the cost thereof and its maintenance and repair, its nature and the cost thereof.

Similar provisions could be profitably adopted by every body corporate which is entrusted with the expenditure of public funds, whether city, county or state.

Small Filtration Plants

The Editor of MUNICIPAL ENGINEERING:

Sir—There is nothing so essential to the human body as good health, and one of the main requirements of health is good water, and in towns and cities where it must be had in large quantities and where it is subject to pollution the question of good water becomes an important one and often requires the installation of some kind of purification system. Rapid sand filters seem to be the favorite, usually in units of two, four or six beds.

This system is very efficient if properly installed and operated. I find some plants without loss-of-head gages, rate controllers, and some without orifice boxes. Some have the air wash, some use water alone. To my mind a plant must be fully equipped to operate efficiently and economically. You can get your plant for from $500 to $2,000 less, without air wash, rate controllers and loss-of-head gages, but you pay for them many times over in chemicals and wash water.

A filter operator should know at all times the condition of his beds, the exact amount of chemical to use, and the flow. He must have complete control of his plant to get results.

To most people the cost of a filtration plant looks unrea-

sonable, until they see the tons of material in one and the numerous valves and fittings. I find some plants overloaded till they can not get results and other plants so large that they are only operated a short time each day; others in which they use turbine pumps, motor driven, which must run at full capacity and speed for economy, and of such size as to require all filters to be operated while pumping and on account of small, clear well must be stopped as soon as pump is stopped. They run two and one-half hours three times a day. While they need the large capacity for fire, it would have been economy to instal another small pump and use two of the filters and operate them continuously, both in electric current and in chemicals, besides giving constant pressure on the service mains.

Most rapid sand filters are rated at two gallons per square foot area. After numerous experiments I find that in some cases a flow of 1.75 gallons per square foot gets the best results. This should be tested out in each plant.

The operator can work out a table by careful experiments for his turbidity and alkalinity and the amount of coagulant for each, so that at a glance he can tell just what is needed for any turbidity, and if he has figured his orifice for each he has it under his complete control.

The washing of the filters is a very important part in the operation of a filtration plant. Where compressed air is used the water is allowed to drain down to within two to four inches of the top of the sand, to be governed by thickness of bed and condition at time of washing, also air pressure used. Then the effluent valve is closed and air valve opened for from three to eight minutes or till bed is thoroly agitated, then air is shut off and the wash water turned on, which must be turned on slowly so as not to blow holes in the bed and form young geysers. All air must be expelled before water reaches top of gutters, then the amount increased until you get about all the flow the bed will stand without carrying sand over. An amount of about seven and one-half gallons per square foot of bed for usually about three minutes will be sufficient for a good wash. The filter beds must be washed at least once every twenty-four hours.

The loss-of-head gages should be adjusted at least once a week. The rate controllers should be examined often to see that they do not get air-bound, or they will pound themselves to pieces. Chemical tanks should be of concrete and have some form of mechanical agitation.

I think all plants should have two orifice boxes, one to feed the coagulant at the entrance of the raw water to the coagulation basins, and the other to feed at the effluent of the coagulation basins. There are times when the raw water is comparatively clear and clean and only needs a small amount of chemical, and if it is added at the entrance of coagulating basins it is all used up before it gets to your filters, but if the chemical was added at the effluent of coagulating basins, then you would get that much desired mat on your filters, the same as you would when using a large amount of chemicals when the raw water is muddy. In any case you must get some of your flock onto your filters if you expect to get efficient bacterial results. Conditions differ at each plant and must be worked out separately.

While the general operation of a filtration plant is simple, yet it is like the Missouri mule—you must watch it. The ever-changing conditions of your raw water make it a constant and interesting study, and the operator should be a live man, with a fair education. In small plants a great many operators have other duties which take up so much of their time that the filters are not properly handled. And again the erecting engineer or filter company's man who makes the test run very often is on the job such a short time that he does not get time to explain and show the man who is going to operate the plant how to handle it in the many changes of the water to get the proper results.

Instead of employing an experienced filter operator, some local man is put in and expected to catch on, which sometimes proves all right and again proves very expensive. Get a good man and keep him and you will get water that is pure, clean and the pride of your town. Fully equip your plant with the best money will buy. Make your buildings substantial, with lots of light and room, and you will have erected a monument that will be a credit to you and your town for years to come.

Closed, Open or Alternate Paving Specifications

The Editor of MUNICIPAL ENGINEERING:

Sir—I note in the May issue of MUNICIPAL ENGINEERING an article under the above caption, signed by Daniel T. Pierce, of Philadelphia.

I have personally been connected with the asphalt paving industry for thirty-one years, and after carefully reading this article it does not appeal to me as being at all in accordance with the facts in the case of paving specifications. I cannot reconcile the proposition of advertising for an office table, specifying nothing but the size of the top, with the modern standardized asphalt paving specifications.

Mr. Pierce must well know that these specifications were written by the best chemical engineers and best qualified city officials in the United States. He must also know that the company he represents are members of the association which wrote the standardized specifications. It is also a fact that all of the large cities in the country are virtually working under these standardized paving specifications, and are advertising for their pavements to be laid under these specifications. They are not advertising for a plastic pavement without any reference to the method of building it, which would be in conformity to Mr. Pierce's wooden-table reference.

I can see no objection to an alternate specification providing it is written without prejudice, which is not true of some of the alternate paving specifications which have come under my observation.

I also wish to refer to the closing paragraph in Mr. Pierce's article in the matter of Indianapolis and Washington, D. C. If the gentleman is familiar with the specifications of those two cities it seems to me a strange comparison, and as this article is undoubtedly written for the benefit of the uninitiated and newly elected city officials, I desire to copy verbatim the Washington, D. C., specifications of 1914 and the Indianapolis specifications of 1914. Previous to 1914 the Indianapolis specifications were standardized, but change of city government in Indianapolis wrote the present specifications, altho I am advised they are not entirely satisfied and will undoubtedly be changed in the near future. The present Washington specifications have been in operation for many years. The Washington, D. C., specifications are as follows:

Asphalt.—The asphalt shall be refined until homogeneous and free from water and shall not at any time be heated to a temperature high enough to injure it. The refined product shall contain at least 90 per cent. of bitumen soluble in carbon bisulphide and 100 parts shall not require more than 30 parts of the flux to produce the asphalt cement described in Paragraph 8c.

Preference will be given to an asphalt cement that is not readily affected by the action of water, provided it is satisfactory in other respects. If an asphalt cement is accepted that is affected by water some provision satisfactory to the Engineer Commissioner must be made to guard against the results of such action, and such work must be included in the price bid. The use of an asphalt under these specifications shall be subject to the aproval of the Engineer Commissioner, and if an asphalt has been proposed for use by the contractor and approved by the Engineer Commissioner no change in the asphalt to be used shall be made unless with the approval of

the Engineer Commissioner. If an asphalt or flux is submitted for use which has not been successfully used for a period of at least two years for paving under conditions similar to those existing in the District of Columbia, its use may be limited to such extent as may be deemed advisable, or it may be rejected for use entirely in the discretion of the Engineer Commissioner.

The Indianapolis specifications are as follows:

The refined asphalts for sheet asphalt pavements shall be either Trinidad Lake, Cubanel, Texaco, Bermudez Lake, Mexican or California. These asphalts are divided into three grades and contractors shall submit bids stating grade or grades of asphalt bid upon.

First Grade. Trinidad Lake Refined Asphalt.

Second Grade. Cubanel and Texaco Refined Asphalts.

Third Grade. Bermudez Lake, Mexican and California Refined Asphalts.

The reader cannot help but note that while Trinidad Lake Refined Asphalt is the only asphalt admitted as first grade in Indianapolis, it is virtually taboo in Washington under the clause, "Preference will be given to an asphalt cement not readily affected by the action of water," and while it seems to be the preferred material in Indianapolis, the best information I have is that no Trinidad Asphalt has been laid in Washington, D. C., for ten years or more.

Who is to decide, the officials at Washington, D. C., the officials at Indianapolis, Mr. Pierce or the prominent engineers of this country who have written the standardized paving specifications? My judgment would be the standardized specifications. GEO. W. LAMSON, Chicago, Ill.

El Oso Asphalt

The Editor of MUNICIPAL ENGINEERING:

Sir—After years of careful study and using all the different paving asphalts known at the time, Mr. F. O. Blake came to the conclusion in the early 90's that with proper care being taken and methods used in refining and with proper care taken in mixing and laying pavements, it was possible to obtain the best results with the California asphalts.

Sor several years he shipped the crude brea, or so-called natural rock asphalt, from various points in California to Denver, Colo., where it was refined and prepared for use as an asphaltic paving cement. Later on a refinery was built near Santa Maria, Cal., which was operated until the controlling interest in the refinery was taken over by eastern purchasers, at which time it was closed down and moved away, as it was thus hoped to stop the use of California asphalt. The trade name under which the material was produced up to this time was "Grizzly," but as the control of the name went with other things it was necessary to adopt a new name. Since Mr. Blake did not intend that all the work he had done should go in this manner, and as the same ideas and methods were to be continued, the name "El Oso" was adopted. (In Spanish "El Oso" means "the bear.") Arrangements were then made with another refining company, then operating, to produce "El Oso" asphaltic cement in accordance with Mr. Blake's specifications.

In 1909 El Oso Asphalt Company was established and a refinery was acquired at Los Angeles, where all the special apparatus necessary for producing El Oso was installed.

The claim of superiority of El Oso is that it is of a uniform grade and penetration, possesses high ductility and malleability and is pure, there being less than one percent insoluble in carbon disulphide or carbon tetrachloride, showing that no overheating has taken place in the refining process. This one thing alone spoils more asphalt than any other.

The "Blake" asphalt mixing plants, built under the Blake patents, now in use in many places, are portable and are very simple in construction, and claim is made that better and more uniform results can be obtained with their use than with any other plant built. One feature of the plant is that it mixes large batches, a whole wagon load at a time. It is practically impossible to burn material with this plant. These plants are not sold, but are leased to customers for El Oso asphalt.

There is well over one million square yards of El Oso pavement now in use in this country and in Canada, and all of it is giving entire satisfaction. Among the cities where this pavement has been laid are Cincinnati and Columbus, O.; Pittsburg, Pa.; Rochester, N. Y.; Creston, Iowa; Topeka and several other cities in Kansas; Portland, McMinnville, Salem and Springfield, Ore.; Tacoma and Hoquiam, Wash.; Los Angeles and Long Beach, Cal.; Denver, Col.

At Topeka, Kan., under Mr. Blake's supervision the now well-known "Topeka Mix" was laid, using Mr. Blake's mixing appliances and El Oso asphaltic cement. This pavement was laid under an El Oso specification which was originated by Mr. Blake. FRED C. BLAKE,

Pres. El Oso Asphalt Co., Los Angeles, Cal.

Convict Labor on Highways

Thirty states have laws providing for the use of state prisoners in road building. The state highway commissioners have control in Arizona, Arkansas, Idaho, Louisiana, Maryland, Montana, Nevada, New Jersey, New Mexico, Ohio, Oregon, Virginia and Washington, the prisoners being turned over by the prison authorities on requisition.

The prison commission has charge of the work of the convicts in Colorado, Indiana, Iowa, Kansas, Michigan, Missouri, North Dakota, Oklahoma and Wisconsin.

County authorities have the prisoners turned over to them in Florida, Georgia, North and South Carolina, a procedure not approved by the best authorities.

New York divides the responsibility for construction of highways and maintenance of camps between the state highway department and the county commissioners, with the state superintendent of prisons in final authority; a division of responsibility which is far from satisfactory.

Massachusetts has just passed an act allowing county commissioners to arrange for working prisoners on highways, with the state highway commission or city and town officials. One rather objectionable provision allows them to arrange with private owners to use prisoners in improving waste land. On highway work, the prisoners are under control of the prison officials and the work is done under the supervision of the state highway authorities.

The boys of the Connecticut reformatory are to build a modern roadway from the reformatory to Milldale and possibly farther and will be paid 50 cents a day for their work. The highway department will see that the work is properly done, provide materials and tools and pay the wages. The honor system in the Mutual Welfare League among the inmates is expected to keep the boys at work during the term of their sentences until paroled.

The highway and prison departments co-operate in Utah, West Virginia and Wyoming, also, the prison department being wholly responsible for the care and discipline of the prisoners and the road department for the work done.

California has just passed an act similar to that in force in Colorado, permitting the Highway Department to make requisition for convicts, organize and maintain camps and supervise the road work, the prison department to retain control over the discipline of the prisoners, who will be worqed under the honor system. The men will probably be at worq on the roads by August 1.

LEGAL DECISIONS

Legal Powers of Cities in Municipal Trading

By J. Simpson.

A well-known authority, referring to the increasing complexity of character of municipal corporations in this country, has said: "Cities and other municipalities in Great Britain are now to be found which own and operate street railroads, river steamboats, gas and electric light works, waterworks, markets, slaughterhouses, cold air stores, ice manufactories, bathing establishments, lodging houses, buildings for entertainments and for music, and engage in the sale and distribution of milk, brick making, etc., the building and renting of dwellings for laboring men, and other commercial and altruistic enterprises, which, twenty years ago, were considered to be within the sphere of individual effort alone. The question whether it is expedient to embark in these enterprises has been referred to the people, and cannot be solved upon a philosophical or economic basis. Municipalities have acquired the right to manage their own affairs, and the will of the voters, however mistaken, will determine what powers should be obtained and exercised. We therefore find an increasing diversity in the character of the public enterprises now undertaken by municipalities and a resulting complexity in their powers, rights, duties and obligations." Dillon on Municipal Corporations (5th ed.), vol. I, sec. 21.

In the case of Holton v. Camilla, 134 Ga., 560, 68 S. S., 472, 31 L. R. A. (N. S.) 116, it was held, for the first time, that, given the necessary statutory authority, a municipality might operate an ice plant in connection with its water and lighting plant, for the purpose of furnishing ice to the inhabitants of the city. In that case the court refused to admit the idea that the city would be engaged in a manufacturing enterprise, and rejected the doctrine that liquid water may be delivered by the city to its inhabitants by flowage thru pipes, but that water in frozen blocks cannot be delivered by wagons or otherwise. Yet in an earlier case in the same court, Keene v. Mayor of Waycross, 101 Ga. 588, the court said: "It might as reasonably be urged that, in order to satisfy its patrons, it was necessary for the city to embark in the ice business as an incident to its right to supply good drinking water to its citizens."

Plumbing. In the case of Keene v. Waycross, 101 Ga. 588, 29 S. E. 42, a plumber engaged in business in the city sought an injunction on the ground that the water works commission had entered into active competition with him in the plumbing business and the keeping for sale and selling plumbers' supplies and furnishings. It appeared that the city was in fact engaged in a more or less general plumbing business, having purchased supplies and furnished materials to and did work for such of its citizens as had applied to its superintendent to have pipes and fixtures placed in and upon their premises. This work had realized a reasonable profit for the city, which contended that, as the plaintiff was an unskillful and incompetent plumber and did not do work to the satisfaction of the city's patrons, it had become necessary for the water works commissioners to engage, to the extent indicated, in the plumbing business in order to render the city's water works system efficient and self-sustaining.

The court stated the general principle governing its decision to be that: "The primary design of the creation of a municipal corporation is that it may perform certain public functions as a subordinate branch of government; and while it is invested with full power to do everything necessarily incident to a proper discharge thereof, no right to do more can ever be implied. Accordingly, in the absence of express legislative sanction, such a corporation has no authority to engage in any independent business enterprise or occupation such as is usually pursued by private individuals. In other words, its legitimate duty is to deal with public affairs, and not those which are purely private and entirely unconnected with a proper administration of its governmental duties."

Applying this principle to the facts of the case, it was held that it was lawful for the water commissioners, as incident to the general powers conferred upon them, to order all work done which was necessary for connecting the city's mains with the pipes of water consumers, or for protecting the city's property from injury or destruction, or for requiring citizens to pay for the water furnished to them; but they could not, without overstepping the bounds of their authority in the premises, engage in a business purely for gain, and the carrying on of which was not essential to the accomplishment of any of these purposes. The commissioners also, it was held, had the power to require that all plumbing connected with the water works should be done in such manner as would effectuate these purposes, and to that end might supervise the plumbing; but it was one thing to devise a plan by which such work should be done, and quite another thing to do the work itself.

Brick Building. It has been held that, in the absence of an excess grant of power, a city cannot engage in the manufacture of paving brick for use upon its own streets, brick being an article in common use and purchasable in the open market. Atty. Gen. v. Detroit, 150 Mich. 310, 113 N. W. 1107 (1907).

Operating Quarry. In Wisconsin it has been held that a city which has express authority to pave and grade its streets, and to purchase such real estate as it deems reasonably necessary or convenient for the city's use, possesses, by implication, all the powers reasonably necessary to the proper exercise of such express powers, including the implied power to purchase a stone quarry either within or without the city limits, for the purpose of obtaining raw material from which to manufacture crushed rock. Schneider v. City of Menasha,

118 Wis. 298, 95 N. W. 94 (1903). In Virginia the opinion of the court is against the maintenance or operation of a quarry either within or without the city limits. In Duncan v. Lynchburg, 2 Va. Dec. 700, 3; S. E. 964 (1900), altho it was merely decided that a city had no implied power to maintain a quarry outside its limits, its power to hold property necessary for its purposes being only exercisable within its limits, it was said that, while it might be convenient for a municipal corporation to own and operate a rock quarry, it is not indispensable that it should do so, in order that it may accomplish the objects of its creation. Following this case it was decided in Switzer v. Harrisonburg, 104 Va. 533, 52 S. E. 174, 2 L. R. A. (U. S.) 910 (1905), that charter authority to repair its streets does not empower a municipal corporation to operate a rock quarry outside of its corporate limits to procure material therefor. In City of Radford v. Clark, 113 Va. 199, 73 S. E. 571 (1912), it was held that the right of a city to operate a rock quarry, either within or without its limits, is neither necessary to, fairly implied in, nor incident to, the duty of the city to keep its streets in a reasonably fair condition, nor essential to the declared objects and purposes of the corporation.

Supplying Electrical Fixtures. In Atty. Gen. v. Leicester, 74 J. P. 304, it was held that, where the statutory authority of a municipal corporation to supply electricity was completed at the consumers' terminals, the business of supplying lamps and fittings could not be conducted by the municipality, the supply of such lamps and fittings being incidental to the use, but not to the supply of electricity.

Selling Fuel. In Op. of Justices, 155 Mass. 598, 30 N. E. 1142 (1892), five jhdges held that the legislature of Massachusetts had not the power, under the constitution, to authorize the cities and towns within the commonwealth to buy coal and wood for the purpose of sale to their inhabitants for fuel; one, Justice Barker, was of the opinion that the legislature could not authorize them to engage in trade merely that it might be better carried on, but might authorize them to deal in fuel, if the necessities of the people could be met only in that way; one, Justice Holmes, was of opinion that the legislature had power to authorize them to deal in fuel. The opinion of Justice Holmes was as follows: "I am of opinion that when money is taken to enable a public body to offer to the public without discrimination an article of general necessity, the purpose is no less public when that article is wood or coal than when it is water, or gas, or electricity, or education, to say nothing of cases like the support of paupers or the taking of land for railroads or public markets." The ruling of the majority was followed in The Municipal Fuel Plants, 182 Mass. 605, 66 N. E. 25, 60 L. R. A. 592 (1903), whether the fuel was to be sold at cost, at less than cost, or at a profit.

In Baker v. City of Grand Rapids, 142 Mich. 687, 106 N. W. 208 (1906), it was held that the transfer of $10,000 from the contingent fund as a special fund to be used for the purpose of selling coal to the citizens of Grand Rapids at actual cost during a time of scarcity of fuel was not a public use and was unauthorized under existing legislation. But it was also held that the city authorities had the right, through the board of poor commissioners, to provide fuel for needy citizens, and under the then existing emergency, where a coal famine appeared imminent, were authorized to purchase such amount of fuel in any market, as, in their opinion, would be necessary for that purpose.

In a very recent case, Laughlin v. City of Portland, 111 Me. 486, 90 Atl. 318, 51 L. R. A. (N. S.) 1143 (1914), it was said that the above mentioned opinions of the Massachusetts justices, while entitled to great consideration, did not have the force of decision. It held that a statute, Me. R. C., ch. 4, sec. 87, authorizing and empowering cities and towns to establish and maintain within their limits a permanent wood, coal and fuel yard for the purpose of selling at cost, wood, coal and fuel to their inhabitants, is constitutional. "The courts," it said, "have never attempted to lay down with minute detail an inexorable rule distinguishing public from private purposes, because it would be impossible to do so. Times change. The wants and necessities of the people change. The opportunity to satisfy those wants and necessities by individual effort may vary. What was clearly a public use a century ago, may, because of changed conditions, have ceased to be such today. * * * On the other hand, what could not be deemed a public use a century ago, may, because of changed economic and industrial conditions, be such today. Laws which were entirely adequate to secure public welfare then may be inadequate to accomplish the same results now."

Maintaining Moving Picture Theaters. A recent Ohio decision holds that, whether a municipality acquires authority "to exercise all the powers of local self-government by adopting a charter, or adopts a charter as an indispensable mode of exercising the authority, the powers to be exercised, being governmental, do not authorize taxation to establish and maintain moving picture theaters." Wanamaker, J., dissenting, State, ex. rel. City of Toledo v. Lynch, 88 Ohio St. 71, 102 N. E. 670, 48 L. R. A. (N. S.) 720.

Dealing in Real Estate. A municipality has no power to engage in the business of buying or selling real estate for profit, either as principal or broker. Hayward v. Red Cliff, 22 Colo. 33, 36 Pac. 796; Bloomsburg Land Improv. Co. v. Bloomsburg, 215 Pa. 452, 64 Atl. 602, where a town was held not authorized to lease a private pleasure park within its limits; Hunnicutt v. Atlanta, 104 Ga. 1, 30 S. E. 500; Champaign v. Harmon, 98 Ill. 491. But it has been held that a municipal corporation may own, control and manage a farmhouse within its limits which has come into its possion in a lawful manner, disconnected from any public use. Libby v. Portland, 105 Me. 370, 74 Atl. 805. And it has been held that a purchase of real estate by a municipality, within its limits, with a view to divide it into lots and streets and to resell it for the purpose of improving the cleanliness and salubrity of the city, and the convenience of the streets, is legal. New Orleans v. McDonough, 2 Rob. (La.) 244.

Selling Liquor. A municipality has the power to engage in the sale of intoxicating liquors where express authority to do so has been conferred upon it by the legislature. The latter, under the police power of the state, may regulate the sale of intoxicating liquors; and, the traffic or business of selling such liquors being a mere incident to the regulation of the sale, and not the object of it, it has always been held that statutes authorizing the establishment of dispensaries for the sale of intoxicating liquors are not unconstitutional. Express statutory authority, however, is necessary to enable municipalities to establish and maintain such dispensaries: such power cannot be implied from the "general welfare clause." Leesburg v. Putnam, 103 Ga. 110, 29 S. E. 602; Barnesville v. Murphey, 113 Ga. 779, 39 S. E. 413; Lofton v. Collins, 117 Ga. 434, 43 S. E. 708; Plumb v. Christie, 103 Ga. 686, 30 S. E. 753; Sheppard v. Dowling, 191 Ala. 1, 28 So. 791; Equitable Loan & Security Co. v. Edwardsville, 143 Ala. 182, 28 So. 1016; Farmville v. Walker, 101 Va. 323, 43 S. E. 558. The option to discontinue at will a dispensary once established by a town can be delegated to the town, notwithstanding that the statute establishing the dispensary provides that no liquors shall be sold in said town except in a dispensary. Ex parte Hall, 156 Ala. 642, 47 So. 199.—*San Francisco Municipal Record.*

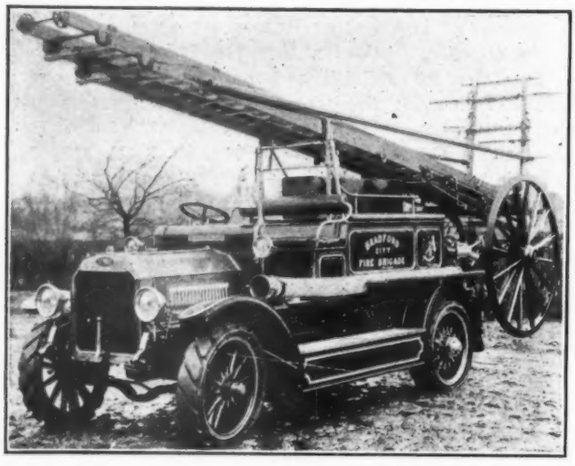
MOTOR VEHICLES

English Motor Fire Engines

In many English cities motor fire engines and motor tenders are used almost exclusively by the various fire departments. One of the Wolseley motor fire tenders designed and constructed at Alderly Park, Birmingham, is utilized by the Birmingham Fire Brigade, a smaller tender of the same type also being employed, carrying eight firemen and driven by a 24-horsepower engine. This larger tender carries fifteen firemen without crowding. It is not provided with a pump, ladder or fire escape, but simply carries a large supply of hose and several hand extinguishers. This English fire tender has a gasoline engine of 40 h. p. capacity, with four cylinders, five inches in diameter with a 5⅛-inch stroke. The car is a part of the equipment of the Birmingham fire brigade and is usually driven at a speed of about thirty miles an hour.

The photograph, Fig. 1, shows an English combined ladder, fire tender and motor driven pump used in Bradford by the city fire brigade. This Dennis turbine pump motor fire car is also provided with a seating capacity for a number of firemen. A similar Dennis 60-h. p. 400-gallon turbine motor fire engine is utilized at Wimbledon, England. There are two engines employed by Wimbledon fire brigade, fitted with 50-ft. sliding carriage escape, a 30-gallon chemical tank, hose reel and 180 feet of hose, electric side and head lamps with dynamo and accumulators, non-skid tires, protectors and direct suction adapter.

MOTOR FIRE LADDER AND PUMPING ENGINE, *Bradford, England, fire department. Their conditions are somewhat different from ours as to danger of fire, but their practice in designing fire apparatus should be of interest.*



This 60-h. p. 400-gallon turbine motor fire engine equipment is driven by a gasoline engine of enclosed vertical type, with cylinders cast in pairs, and valves mechanically operated and placed on opposite sides, with air-tight aluminum covers over same. It has a pressure feed lubricating system on latest principle. This engine will develop a maximum of approximately 65-h. p. on the brake, and is 5-in. bore by 7-in. stroke, designed in all details essentially for fire brigade work.

There is a high tension waterproof Bosch magneto used and also high tension electric accumulator and distributer, connected with two sets of sparking plugs with turnover switch, to be coupled up in such a way that each separately or both ignitions together can be used, eight sparking plugs being used in all. The clutch is leather lined, cone-shaped, of large diameter, with outside adjustment for spring tension and a universal joint contained in the clutch to avoid all strain on the crank shaft thru any distortion of the frame which may occur on uneven ground.

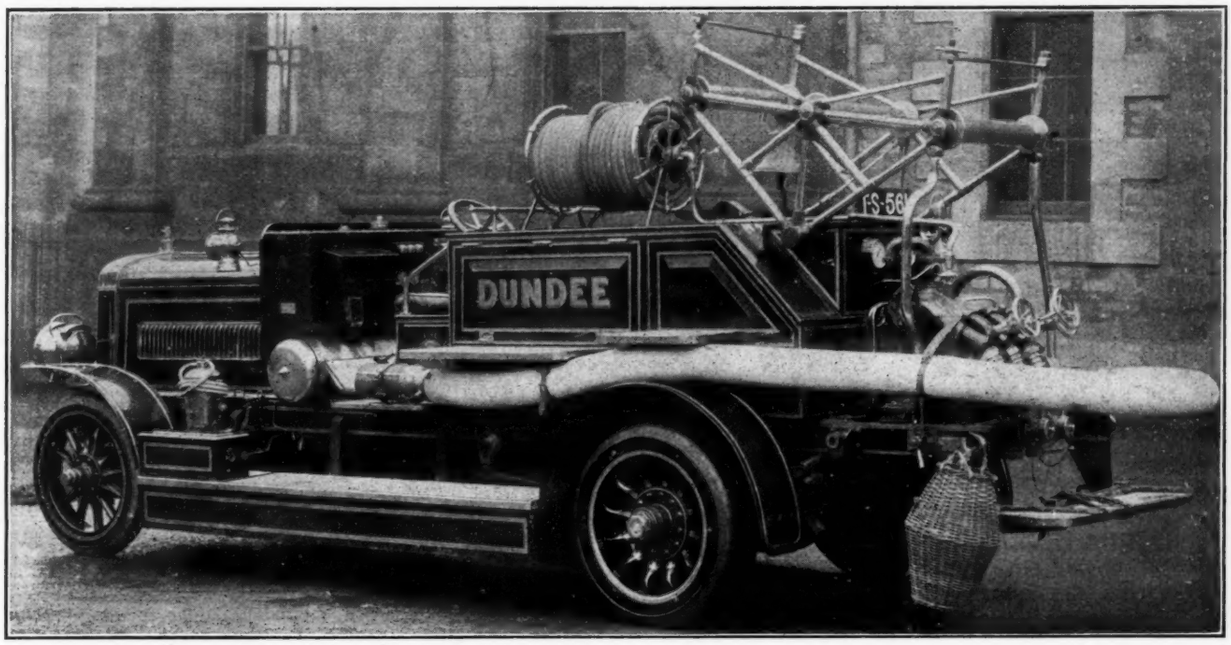
The speed gear has alloy aluminum casting, with four speeds and reverse, which would enable the machine to attain a speed of 30 miles per hour on the level. There is a gate control with ball bearings. It is said that the machine is capable of ascending a gradient of 1 in 5 with full load. The cooling system has a water circulation by gear-driven centrifugal pump of large capacity, and radiator, having brass envelope with a suitable fan for the induced draught. A separate by-pass from the pump is taken to the top of the radiator to afford additional cooling when pumping.

The fire pump is a centrifugal multi-stage high pressure turbine type of the Gwynnes design. The pump approximately delivers 400 gallons per minute at 120 lbs. pressure and will deliver up to 500 gallons per minute at lower pressure when working thru a 100-ft. length of 2¾-inch unlined canvas hose, and is also capable of drawing water 27 ft. with ease and certainty. There are pressure and vacuum gauges attached to the dashboard in front of the driver.

The air-pump charging apparatus is of interest. This charging apparatus is in duplicate, there being two double acting cylinders, each working independently and constructed of a capacity capable of obtaining water from 26 ft. to 27 ft. in 20 to 25 seconds. The air pump is brought into action by a lever from the driver's seat, and on the water being obtained, the outlets, if required, automatically open.

The car is electrically lighted, the lamps including two side and one tail with 4-volt electric battery operated by a switch placed on dash. The storage battery consists of an accumulator set with 40-ampere-hour 4-volt continuous current for ignition and one 60-ampere-hour 4-volt battery for the electric lamps.

The illustration, Fig. 2, shows another English motor fire engine designed at Alexandria, Dumbarton, by Argylls, Ltd.,



GASOLINE MOTOR FIRE PUMPING ENGINE, *6-cylinder, 75-horse-power, with compressed-air starter, four forward speeds and reverse. High pressure turbine pump, capacity 450 to 500 gallons a minute with 28 feet suction and 140 pounds water pressure, with starter to save time in starting. Carries 10 men, 2,000 feet of hose and 30-foot telescoping ladder.*

and this type of fire car has been very successful thruout Great Britain.

The 75-h.p. Argyll 6-cylinder gasoline motor fire pump is equipped with a self-starter. The motor has a bore of 133 mm. and a stroke of 160 mm. The engine is self-starting by means of compressed air. The gear box is arranged for four forward speeds and reverse, with switch on dash.

The fire pump is a high pressure Worthington turbine pump, discharging 450 to 500 gallons per minute with suction lift of 28 ft. and maintaining pressure of 140 lbs. per sq. in. The Argyll starter gives the pumps an immediate start. The body is designed to seat ten men and to carry 2,000 ft. 2½-inch canvas hose, also a 30-ft. telescope ladder.

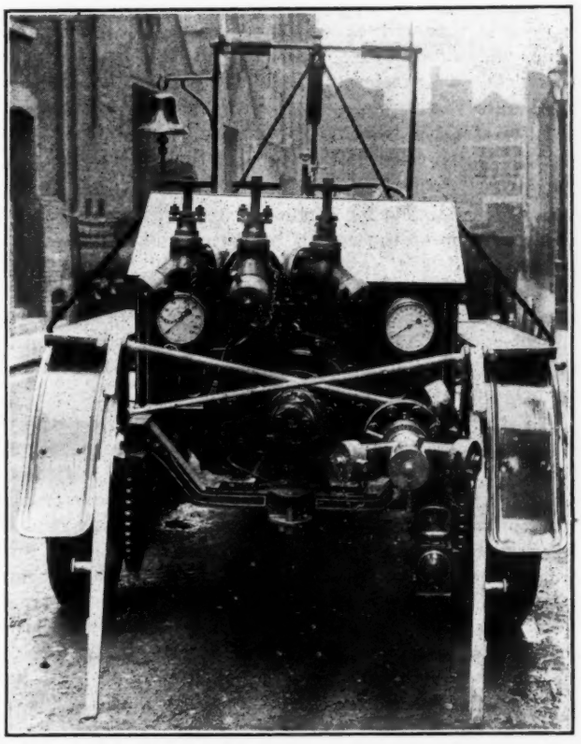
The accompanying illustrations, Figs. 3 and 4, show an English equipment delivered to the Austrian naval authorities. Fig. 3 shows a Lacre-Worthington fire engine, used in the dock yards at Pola and the surrounding districts. The chassis of this vehicle is of 2-ton capacity and is fitted with a 4-cylinder 38 to 50-h. p. engine. The speed of this machine, fully equipped and manned, is about 22 miles per hour, and it can negotiate gradients up to one in four, these figures being specified by the naval authorities.

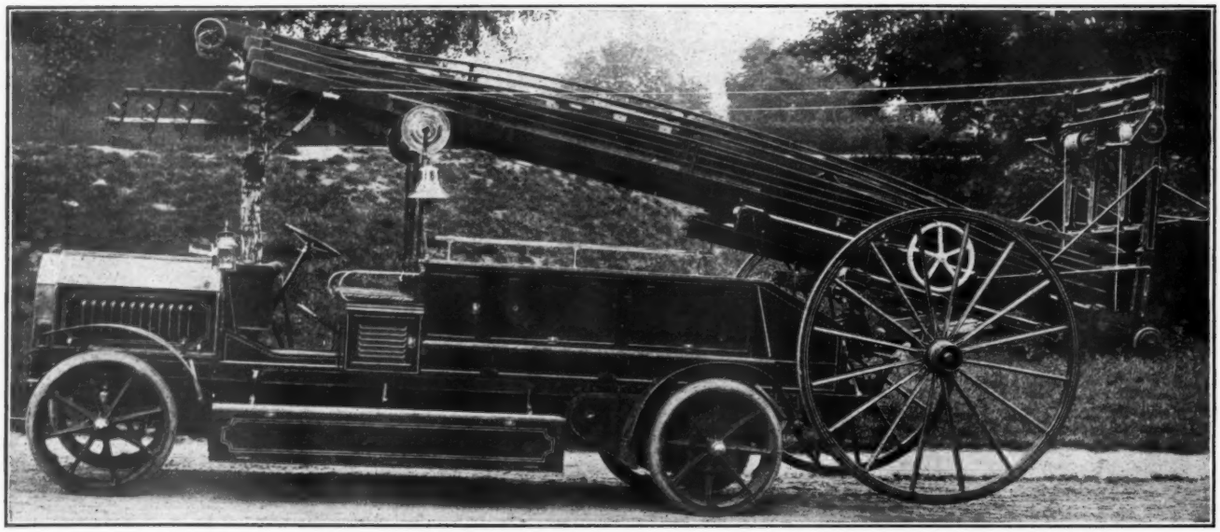
The chassis is fitted with the Worthington pump of centrifugal 4-inch 6-stage type, with three-way distributer, and is capable of throwing 140 gallons per minute to a height of 96 feet, and lift from a depth of 20 feet, the pump working at 1,820 revolutions per minute. A rotary exhauster is fitted for priming the pump when starting, and both the pump and exhauster are controlled by a lever which is situated on the left-hand side of the driver's seat.

Fig. 4 shows a fire escape so mounted on the vehicle that the weight is equally distributed over the front and rear axles. The ladders are of the 3-stage sliding pattern, and when fully extended are 63 feet long. In addition to this there are three pompier hood ladders. The equipment includes a jumping sheet and fifteen 63-ft. 2½-inch hose sections and seating accommodation for eight men. There is attached to this machine a hose cart and a coupling arrangement has been fitted at the rear for this purpose.

Another most practical automobile fire car of English construction is the Hallford motor fire tender, designed by J. and

FRONT VIEW OF MOTOR DRIVEN *fire engine with turbine pump.*





COMBINATION LADDER AND MOTOR FIRE ENGINE *developed for use in London, England.*

E. Hall, Ltd., of London. This motor fire hose tender chassis has an aluminum crankcase and four cylinders, with 110-mm. bore and 140-mm. stroke, giving 32 h.p. at 1,000 revolutions per minute- The inlet and exhaust valves are operated by camshafts placed on opposite sides of the engine. The valves are of nickel steel, and are interchangeable and the timing wheels and governor are entirely enclosed. The ignition is by Bosch high tension magneto.

The crankshaft, mounted in large ball bearings, is of chrome nickel steel. The system of lubrication is by pump providing a constant level of oil, into which scoops on the connecting rod ends dip at every revolution. This fire engine is controlled by levers conveniently placed in front of the driver, one mounted on the steering wheel and connected to the throttle valve which regulates the supply of gas to the engine, the other being connected to the ignition timing mechanism. An accelerator pedal is fitted so that the driver can operate the throttle valve without removing his hands from the steering wheel. The engine is also fitted with a governor, which controls the speed of the engine and thereby economizes the consumption of petrol (gasoline).

Provision is made for cooling by a large radiator and fan, the circulation of the water being maintained by a pump. This fire car has a speed of approximately 15 and 25 miles per hour. There are two brakes provided, the first acting on a drum on the gearshaft and the second acting inside of drums on the rear road wheels. There are long flat springs utilized to allow of easy riding at high speeds and the driving chains are enclosed in aluminum oil-tight casings.

The steering gear is of the Ackerman front axle type with worm and sector steering. The wheels are of cast steel fitted with 36-in. by 3½-in. twin tires on rear wheels and 34-in. by 3½-in. front tires. The gasoline tank has a capacity for 30 miles' run with full load. The body is of mahogany panneling with oak framing. There are two compartments, the former compartment measuring approximately 22 inches long, 33 inches wide and 21 inches deep, and the hose box under gear measures approximately 25 by 28 by 15 inches. The body is fitted with sliding doors at side and hinged door at rear with a bottom hose box left open. The hand rails are of polished brass, and the footboards and dashboard are edged with brass and covered with 3-16-in. cork carpet, the footboards being stiffly stayed and ironed to stand heavy usage.

A 35-ft. Ajax trussed extension ladder is mounted on the top and so constructed that the sliding ladder may be detached and used independently, the ladder supported on stanchions and rollers, so that it may be removed by one man. The chemical tank has a capacity of 30 gallons and the hose reel is conveniently located on the top, as shown in the protograph.

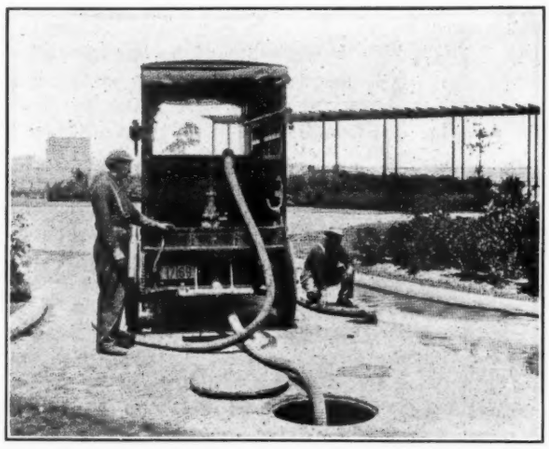
Electric Pump Wagon

By R. E. Plimpton

The Edison Electric Illuminating Company, of Boston, has in service at the present time two pump wagons. The pump wagon is a 2,000-pound electric wagon, which has mounted inside its panel body a motor-driven rotary pump. The pump motor is connected to the vehicle battery and the pump thus driven will litf 90 gallons of water a minute from the manhole. The work was formerly done with hand pails. Two men with a small hand cart were sent from manhole to manhole and could take out about 5 gallons of water a minute.

The Edison Company has found the greater speed of the

ELECTRIC PUMP *on automobile truck for pumping out manholes on underground distribution system of Boston's electric light and power system.*



place, especially advantageous in the downtown district of Boston, where the traffic conditions are notoriously bad.

While the pump wagons are assigned regular routes, they are also used a great deal for emergency work. The drivers outfit not only in pumping but also in moving from place to have strict orders to telephone headquarters hourly. The accompanying log, for instance, shows that the G. V. pump wagon after pumping out some manholes at the big L street generating station, made a number of stops for inspection and test at manholes. This means that the pump wagon was turned over to an underground trouble gang which made tests at various manholes. Wherever necessary these manholes were pumped out. Just as soon as the trouble was cleared, the pump wagon again proceeded on its regular work.

The pump wagon averages 20 miles a day of actual travel and during that time will clean out from 15 to 20 manholes. This figure does not represent the number opened and inspected. During the first ten months of 1914 the crews of the two wagons opened 13,700 manholes, from 9,500 of which was pumped 3,130,000 gallons of water.

On the day the log was taken the G. V. pump wagon actually removed 10,080 gallons from 13 manholes, using 58 ampere hours from the vehicle battery for the work. So that while the battery discharge was 164 ampere hours, only 106 were used for driving the vehicle the 16.6 miles. In ordinary weather the consumption for driving vehicle averages 4.7 per mile, while the total consumption (driving and pumping) is about 5.7 ampere hours per mile.

DAILY TRUCK REPORT.

Location of Stop	Arrived Hour	Left	Odometer	Ampere Meter	Remarks
Edison Garage		8:19	876.8	0	
L. street Edison Power Plant	8:40		879.8	15	
*L. street Edison Power Plant	8:43	9:23	879.8	36	Pumping
L. street Edison Power Plant		9:31	879.8	36	
Fargo and E street	9:37	9:40	880.5	41	
Summer street and Dorchester avenue	9:46	9:52	881.4	46	Insp. and Test at manholes
Farnsworth street and Congress street	9:54	9:56	881.6	47	Insp. and Test at manholes
Pittsburgh street and Congress street	9:57		881.7	48	
*Pittsburgh street and Congress street	9:59	10:04	881.7	51	Pumping
*Pittsburgh street and Congress street	10:13	10:15	881.7	52	Pumping
Pittsburgh street and Congress street		11:08	881.7	52	
Columbus avenue and Berkeley street	11:23	11:45	883.3	64	Insp. and Test at manholes
Columbus avenue and Granville place	11:47	11:58	883.5	65	Insp. and Test at manholes
Edison Garage	12:14	1:39	886.0	78	Lunch
Fargo street and B street	2:05		889.6	100	
*Fargo street and B street	2:08	2:15	889.6	103	Pumping
*Fargo street and B street	2:16	2:21	889.6	105	Pumping
Fargo street and B street		2:23	889.6	105	
Summer and B street	2:24		889.7	106	
*Summer and B street	2:26	2:39	889.7	113	Pumping
*Summer and B street	2:41	2:52	889.7	119	Pumping
Summer and B street		2:59	889.7	119	Grade Crossing delay
Summer near N. Y. N. H. tracks	3:01		889.8	121	
*Summer near N. Y. N. H. tracks	3:04	3:10	889.8	124	Pumping
*Summer near N. Y. N. H. tracks	3:12	3:17	889.8	127	Pumping
Summer near N. Y. N. H. tracks		3:19	889.8	127	
Congress and Stillings street	3:21		889.9	128	
*Congress and Stillings street	3:23	3:28	889.9	131	Pumping
Congress and Stillings street		3:31	889.9	131	
Congress and Sleeper street	3:33		890.0	133	
*Congress and Sleeper street	3:36	3:44	890.0	137	Pumping
Congress and Sleeper street		3:47	890.0	137	
Congress and Estes place	3:48		890.2	139	12 min. to grease pumps
Congress and Estes place	4:03	4:06	890.2	140	Pumping
Congress and Estes place		4:09	890.2	140	
Washington and Savoy street	4:26		891.8	152	Heavy traffic
*Washington and Savoy street	4:30	4:32	891.8	153	Pumping
Washington and Savoy street		4:34	891.8	153	
Edison Garage	4:50		893.4	164	

TIME OUT OF GARAGE.

	Hrs.	Min.	Per cent total time
Running Time	2	26	28.6
Pumping Time	1	52	21.9
Lunch and other delays	4	13	49.5
Total	8	31	100.

Capacity and make of truck—2,000 pounds, G. V., 60-A6 Ed. Batt.

In service of Edison Electric Illuminating Co., Boston, Ed., No. 86, G. V. No. 1897.

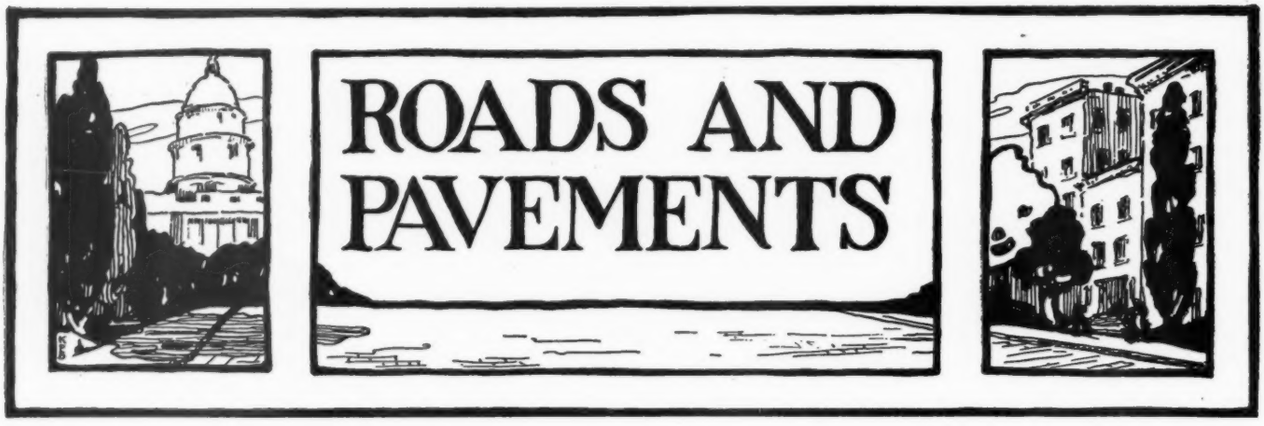
Place—Boston, Mass.

Weather conditions—rainy.

Nature of service—Pumping out manholes.

Road conditions—Belgian blocks.

*Entries with asterisk prefixed show time of starting and stopping pump motor.



Concrete Pavement on Heavy Grade in Wisconsin

By Stanley E. Bates.

Grades greater than 15 per cent. on city streets are few and far between. Reports come in of 20 or 30 per cent. or even greater, but upon investigation these are generally found to be greatly exaggerated.

Streets of even 10 to 15 per cent. are difficult of ascent for either horses or automobile traffic unless the pavement is both smooth and of such a character as to give a good gripping surface to horses' feet and automobile tires.

In Milwaukee there are two stretches of steep grade, namely, on Eighteenth and Nineteenth streets between Clybourn street and St. Paul avenue, where the grades are 13.5 per cent. and 15.3 per cent., respectively. Before improvement these streets were little better than storm water courses and it was an extremely rare occurrence for any kind of traffic to try the ascent. In order to remedy this condition it was decided last year to pave them with concrete.

The concrete pavements of Sioux City, Iowa, some of which lie on 16 per cent. grades, were taken as a model for the construction, tho some changes were made from the Sioux City specifications.

Both streets were paved 30 feet wide, the thickness of concrete ranging from 6 to 8 inches. Unprotected, transverse joints of tar and felt were spaced 25 feet apart and the concrete was crowned 4 inches.

The aggregates used in this work were sand, which was clean and well graded, and crushed granite from Waterloo, Wis., ranging in size from 2 inches down. The surface was not corrugated but was finished rougher than is common for pavements on more level grades.

The illustrations give evidence of the good traction afforded by the concrete to all types of vehicles. Both wagons and motor vehicles are shown ascendoing the 15.3 per cent. grade on Nineteenth street, without danger of slipping and with much less effort than one taking the steepness of the grade into account would suppose. The oil tracked on to the concrete from the street below also indicates that a considerable amount of traffic now seeks this route.

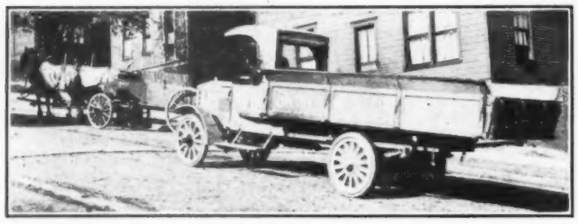
One of the horse vehicles shown is a delivery wagon of the Solvay Coke Co. and the motor truck is one just completed by the Sternberg Motor Truck Co., of West Allis, Wis. This company, as well as others in Milwaukee and vicinity, have been using these streets regularly, since the improvement, to test out all of their newly constructed trucks under a heavy load, before delivery to the purchasers.

In spite of the fact that these pavements were laid on a crowned subgrade, and were not reinforced, they have come thru their first winter well. In a recent letter, in which the work was described in some detail, Mr. Simmons, commissioner of public works, concluded with the following paragraph:

"The streets came through the winter in fine shape, an inspection revealing no defects at the present time."

Many other cities have used concrete on heavy grades with equally good results, among which may be mentioned Sioux City, Iowa, and Kansas City, Mo.

MOTOR TRUCK AND HORSE TRUCK *ascending concrete pavement on Eighteenth street, Milwaukee, Wis., with 15.8 per cent. grade.*



Program of Permanency on the Pacific Highway

By Arthur P. Denton, Engineer, King County, Washington.

Following a successful brick paving venture in 1912, King county, Washington, elected to spend its entire share of the state permanent highway fund for the years 1913 and 1914 for this form of construction. For this reason, motor tourists who visit the exposition by a northern route this year will have opportunity to enjoy roads which compare well with any of the celebrated highways of the East.

The first contract was let on May 9, 1912, for 2.75 miles of road at a cost of $59,523.92. This was during the regime of my predecessor, J. R. Morrison. Aside from the fact that No. 2 brick were used, the specifications aimed at a substantial and permanent highway. The base was of concrete, 5 inches in thickness, with curbs molded in the same piece. There were longitudinal expansion joints.

This road has given good service and the immediate satisfaction expressed with it, led to the adoption of this type of road at the time I took office in 1913 for three jobs undertaken that year. These included 2.9 additional miles on the Pacific Highway, 6.13 miles on the so-called North Trunk road and 3.3 miles on the Bothell boulevard.

The contract called for $88,681 in the case of the Pacific Highway extension, for $151,280 in the case of the North Trunk road and for $84,918 on the Bothell road. The first was 20 feet in width and the others each 18 feet.

CLEARING AND GRUBBING *required along the Cascade Scenic Highway in King, Snohomish and Chelan counties. Maximum grade 7.2 per cent. Grading cost nearly $8,000 a mile. Note the four men all standing on one stump.*

With the completion of a third contract on the Pacific Highway in the following spring, a thru pavement was given between Seattle and Tacoma. Counts of traffic have shown as high as 5,000 vehicles per day on this road, rivaling some of the most used city streets in Seattle, yet the road exhibits very little sign of wear. The Bothell road has a traffic approximating 3,000 vehicles per day at certain seasons. Its only repairs have been due to the settling of a fill in the subgrade. There has been less traffic on the North Trunk road, but, as the city of Seattle is now laying a pavement to connect with it, there is a prospect of greater use in the near future.

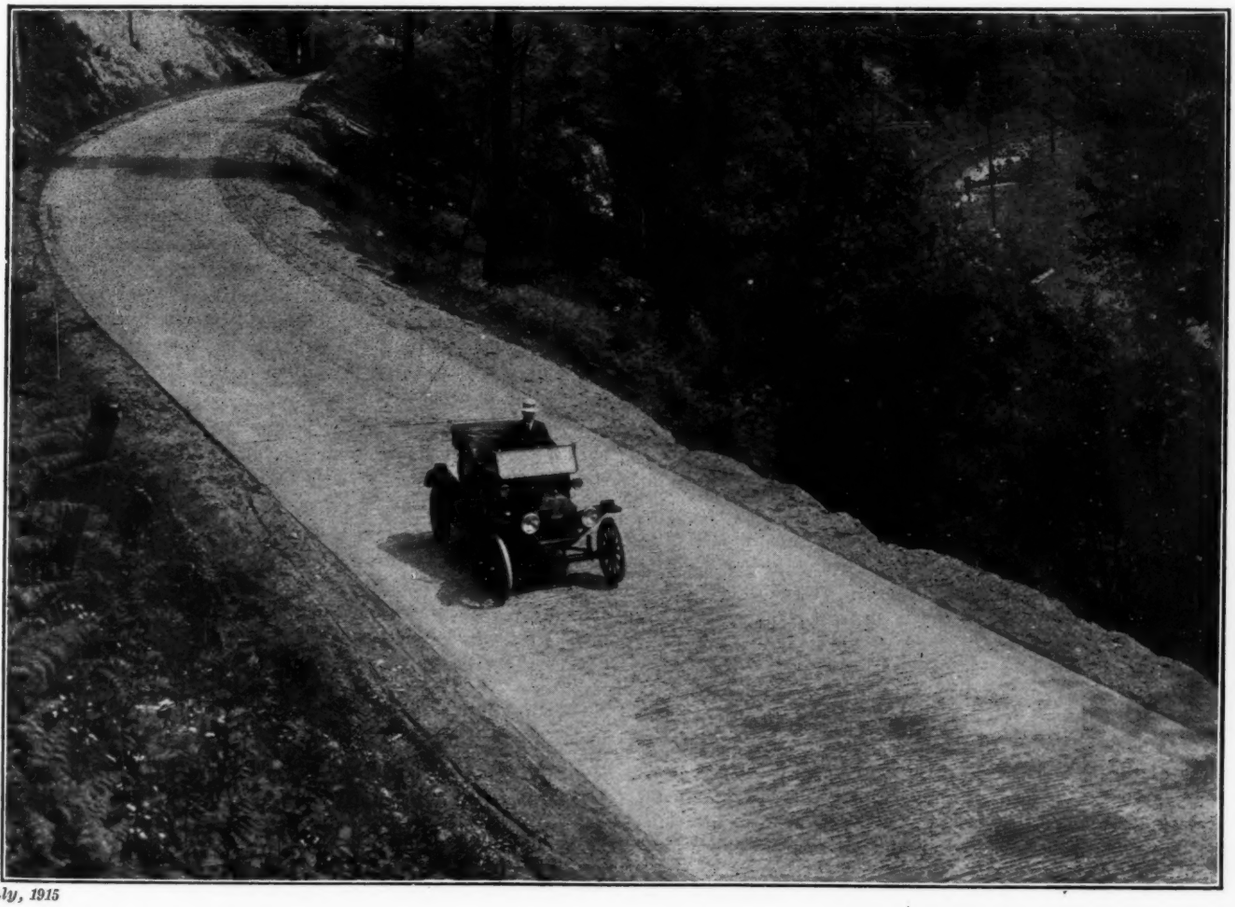
Our 1914 program also included a contract for 1.64 miles of brick on the Kirkland-North Bend road. This was an 18-foot roadway, laid at a cost of $42,978. It has required no maintenance to date, altho at times traffic reaches 1,200 a day.

At the present time there is under construction 1.4 miles of 20-foot paving, which involves the expenditure of $52,755, including the tearing up of considerable worn-out macadam and 0.7 of a mile of new grade and drainage.

Mention should also be made of 1,000 feet of experimental brick road laid in 1913 by the Denny-Renton Clay and Coal Company, partly at its expense. This is a part of the Pacific Highway and immediately adjoins the city limits of Seattle. It has required no maintenance.

In all, we have 20.13 miles of brick road in King county, laid at an average cost of $27,900 per mile. In considering this cost, our generous widths should be taken into account and the structural difficulties due to a hilly country. Our practice on curves of greater than five degrees has been to raise the outer side of the pavement and to provide extra width on the inner side. From a scenic standpoint, as well as that of easy transit, our roads are a delight to the tourist. The Bothell boulevard, for example, skirts Lake Washington for nearly its entire length. But the practical advantage of these permanent highways, after all, outweighs the mere pleasure of travel. There is a constant stream of heavy trucks

PACIFIC HIGHWAY, *between Seattle and Bothell, called Bothell Boulevard, laid in 1913, 18 feet wide with No. 2 brick on 5-inch concrete base and with 5-inch concrete curbs.*



over many of them and the freight that they transport has had an appreciable effect upon the volume of railroad haulage. When present usefulness and long prospective life are considered, I feel certain that such roads represent a decided economy.

I feel certain that the continuance of this policy will make the Pacific Highway second to none of America's great roads.

New York Exhibition of Street Cleaning Apparatus and Appliances

Encouraged by the success which attended the exhibition of November 23-28, 1914, and by the generally expressed desire for its repetition, the New York department of street cleaning announces that it will hold its second annual exhibition of street cleaning apparatus and appliances in the First Regiment Field Artillery Armory, Sixty-eighth street and Broadway, New York City, during the week beginning Monday, October 11, 1915.

The exhibition of 1914 was more or less experimental, and its results made manifest beyond all doubt the newly awakened and constantly increasing interest of the people in the vital question of public cleanliness. It also made clear the eager desire of public officials to improve their methods, as well as the alertness of the inventors and manufacturers who are striving to meet the demand for improved mechanical equipment.

During the nine months since the first announcement of last year's exhibition, there has been more discussion of street cleaning problems in New York than in the ten preceding years. Health organizations, civic societies and business men's associations have given the subject a prominent place in their lists of preferred topics and the magazines, technical journals and general newspapers are giving liberally of their space to its discussions. For the foregoing, and many other reasons of lesser importance, there is assured confidence in the success of the forthcoming exhibition, and firm belief that it will be of incalculable benefit to the service of street cleaning and its contributing agencies.

At the time of this year's exhibition it is expected the "Model District," for which a special fund was provided by the board of estimate and apportionment, and which is to be equipped with modern apparatus, will be well under way. The "Model District" should prove an attraction to manufacturers and inventors, as well as to visiting officials.

The street cleaning apparatus eligible to entry in the forthcoming exhibition includes all sorts of brooms, brushes, sweeping machines, flushing machines and other equipment or appliances used in cleaning streets and removing snow; carts, wagons, motor trucks or other vehicles used for collecting garbage, ashes, rubbish and street sweepings; conveyances for transporting refuse, by water or by rail; methods for the disposal of garbage, ashes, rubbish and street sweepings, including garbage reduction work, garbage crematories, incinerators, destructors, etc. Exhibitors are not required to pay entrance fees; legitimate street cleaning apparatus and appurtenance will be given free space in the exhibition hall. Other costs of placing their exhibits and all risks must, however, be borne by the exhibitors, excepting that storage will be provided, without charge, for pieces of apparatus which arrive in the city of New York prior to the evening of October 9.

On Saturday, October 9, there will be a parade, under the auspices of the New York department, composed of the D. S. C. band, several hundred uniformed men ("White Wings") and selected pieces of the department's equipment. Positions in the line will be assigned to exhibition entries whose owners desire to take part in the parade.

The exhibition is under the directorship of Joseph R. Buchanan, acting under J. T. Fetherston, commissioner of street cleaning of New York, with office on the twelfth floor of the Municipal Building.

French Highways in the War

In a letter to one of his instructors, F. W. Zinn, a graduate from the Engineering Department of the University of Michigan in 1914, gives some of his experience as a soldier in the French army, one of the first Americans to enlist. He has the following to say concerning the French roads and their durability under the severe punishment they receive under army transport conditions, taken from *The Michigan Alumnus:*

"I have had a very good chance to study French roads. In the two months of training we had in Paris and Rouen and later in Toulouse, we covered a good many miles of them and the localities were so widely separated that we had a good basis for comparison. No French roads are bad, but those in the Midi, especially the ones close to the Pyrenees, can't even compare with those on the frontier.

"You can have no idea of the terrific punishment that some of these ordinarily light traffic highways have taken since the beginning of the war. The continual stream of Paris motor-busses that help make up the army transport, together with the heavy artillery and ammunition wagons, are enough to kill an ordinary road in a month, but these routes honestly seem to thrive under it. One of these department roads crosses the hill we occupy very close to this point.

"From here to the rear every night there is a very heavy artillery traffic, while on the front side of the hill, where the road goes toward the German position in Craonne, there hasn't been a vehicle in months. We go along there sometimes at night—no one, unless he wants to commit suicide, would go out there in the daytime—and from surface indications at least, the road to the rear is in as good condition as this stretch.

"In this country there are no fenced fields or scattered farmhouses to trouble the road engineer, but there are hundreds and hundreds of little villages to be linked up. A little farther south, in the grape country around Reims, the question of grades must be pretty bothersome.

"The general details of design seem to be about the same here as they are in the States. There are plenty of chances to study the cross-section. Every "*marmite*" that explodes makes a good test pit. The depth of the metal isn't unusually great when you look at it, but when you have to dig thru it it is another proposition.

"A while ago—the night before the Kaiser's birthday, to be exact—the Germans made a fairly heavy attack on our right.

"Our section was detailed to cut the Pontivert road. French rockets and German flares were going up by the dozen, and all the artillery around us, even the 105's in the reserve batteries, were working up to full capacity, making such a racket that you couldn't hear an order. That was an ordinary harmless looking piece of road that we were trying to dig thru, but, say, I'd swear that it seemed as if the thing was four feet thick and solid rock all the way down.

"We have helped the 14th artillery build a stretch of five kilometers of corduroy thru a swamp near here. The big timber has all been used for fortifications; so we used bundles of fagots instead of logs for the foundation. But the thing has to be watched pretty carefully, or the dirt covering wears thru, exposing the branches, and then it goes to pieces very rapidly."

Protection of Metal Structures

Boston is a city of bridges. Within the city limits are 186 highway bridges, to say nothing of many railroad bridges. In the metropolitan district of greater Boston, the number of bridges of all kinds is well up into the hundreds. In this section, therefore, experience in the use of steel in bridge structures under various conditions has been extensive.

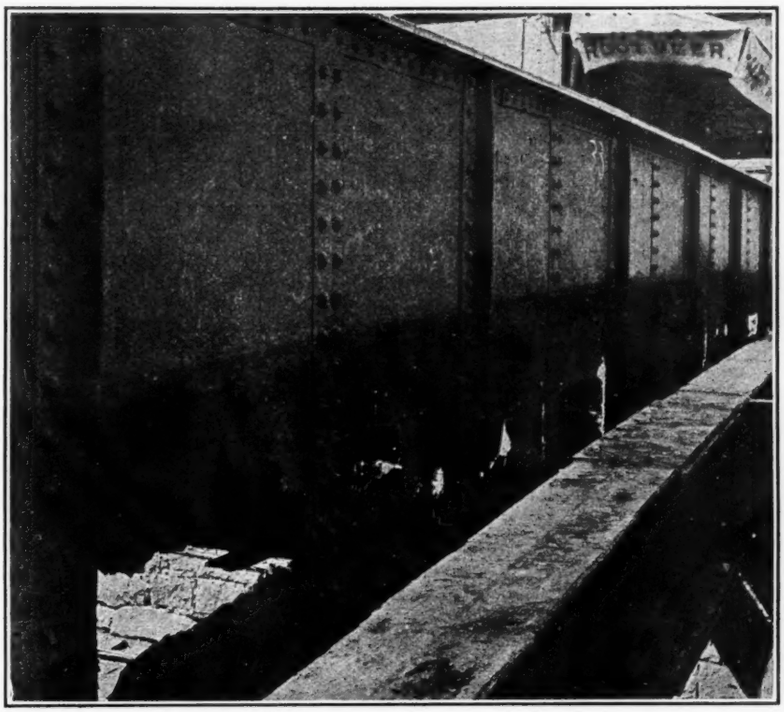
In discussing protection, Frederic H. Fay, of Fay, Spofford & Thorndike, consulting engineers, Boston, formerly division engineer in charge of bridges and ferries, city of Boston, in a paper before the Engineers' Society of Western Pennsylvania, considers particularly the subject of metal corrosion. He outlines the conditions under which metal structures decay and against which protection is necessary. Iron will not corrode in water unless air is present. The agents present in the air which accelerate rusting, especially in or near cities where much fuel is consumed, are numerous. Sulphur dioxide and soot are probably the most destructive, because together in the presence of moisture they produce sulphuric acid. The action of these two agents is most marked in railway tunnels and bridges.

Experience in Boston has shown that the corrosion of metal bridges has been due principally to one or more of the following causes: Exposure to locomotive gases; exposure to sea water; exposure to surface water leaking thru bridge floors; over-stress of the metal, by which corrosion has been hastened.

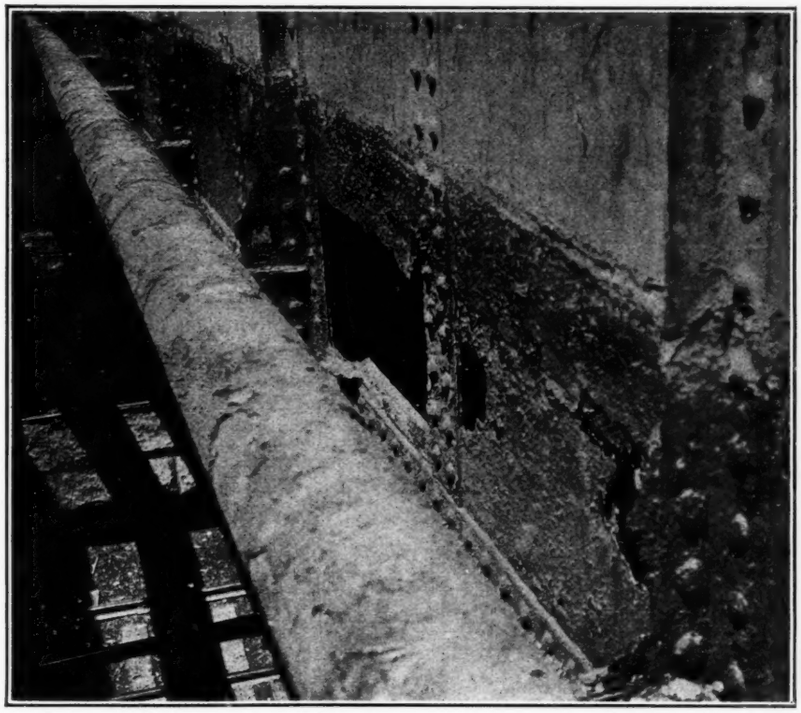
Two views show typical rust conditions caused by locomotive fumes. Striking examples of corrosion are seen in the views of the old Washington street bridge of the Boston and Albany railroad. The webs of the plate girders beneath the bridge floor have been completely eaten away over large areas, leaving holes, in some cases, large enough for a man to crawl thru.

While many paints have given satisfactory results on metal structures under ordinary conditions, they have not proved an effectual protection of metal work under extreme conditions, such as exist in bridges over railroads. The use of wooden ceiling protection confines locomotive gases and makes corrosion more rapid than in the open. Sheet lead has, in some cases, been worn away by locomotive blasts until it began to fall upon the trains beneath. Asphalt coating, after six years' service, has been found in good condition.

But concrete or mortar has proved by far the most satisfactory protection for metal structures over railroads. It should be properly reinforced with steel. The best results and the greatest degree of safety will be obtained when the steel reinforcement is thoroly attached to the metal member.



CORROSION OF IRON GIRDER *in Washington Street Bridge over Boston and Albany Railroad in Boston, Massachusetts. Two views.*



MISCELLANEOUS

Convention of American Society of Municipal Improvements

The American Society of Municipal Improvements will meet in Dayton, O., October 12-15, with preliminary meetings of the committees on standard specifications and on standard forms on October 11. The city of Dayton is preparing a special program for two sessions of the convention, which will be of great interest and value, and the National Paving Brick Manufacturers' Association tenders the society a dinner on one evening. The program in general is well under way. Three sets of specifications will be presented for consideration and adoption and possibly some changes in specifications adopted last year.

Northern Pacific Coast rates are in force until September 30, good returning until October 31. California rates are only available on four days in August, except the regular 9-months excursion tickets available at all times.

The New Water Works Directory

The McGraw Water Works Directory is now ready for delivery. It fills a need that civil engineers have felt since the last issue of the "Manual of American Water Works," edited by M. N. Baker, was published in 1897.

It lists in its 615 pages, 5185 towns in the United States, Canada, Philippine Islands, Porto Rico and Hawaii, giving as to the water works in each, the essential facts about ownership, management, supply, purification, pumping equipment and rates. It is arranged alphabetically by states, with the towns in alphabetical order under each state. The description of each water works is given under the town which it supplies and a statistical summary by states closes the book. The price is $15 and it is published by the McGraw Publishing Co., New York City.

Lincoln Highway Guide Book

The Lincoln Highway Association, Detroit, Mich., has published a guide book of the entire route, from New York to San Francisco, in the standard automobile guide book form, which can be obtained for 50 cents. A map of the route with connecting lines and a list of the cities and towns passed thru may be obtained for an additional 25 cents, folded in a convenient cover.

Statistics of the cities and towns, information about hotels, prices of oil and gasoline, washing, etc., location of water, lodging and meals where they are scarce are given in the order the towns are reached from New York, and an alphabetical index makes them easy to find.

The instructions to tenderfeet about car and supplies, car camp and personal equipment, provisions, camping, state license regulations, etc., should be of much help.

Technical Associations

The general program of sessions and excursions of the International Engineering Congress and the engineering society conventions to be held in conjunction therewith between September 16 and 25, at the Panama-Pacific Exposition, San Francisco, Cal., is ready for distribution by Secretary W. A. Cattell, 417 Foxcroft Building, San Francisco, Cal.

The New York Electrical Society at its meeting June 15, elected Elmer A. Sperry president, and Geo. H. Guy secretary.

Technical Schools

The University of Michigan is attempting the establishment of a Municipal Research Bureau under the Department of Political Science in connection with courses of study on municipal administration. Its purpose is to collect and collate material and circulate information concerning the problems of municipal administration, with special reference to Michigan cities, with such investigation of concrete conditions and problems as may occur practcable.

Civil Service Examinations

The U. S. Civil Service Commission will hold examinations at the usual places, as follows:

July 27: Instrument maker and mechanician in Bureau of Standards, Department of Commerce, at $900 to $1,020 a year.

September 15: Aids and computers on Coast and Geodetic Survey; copyist topographic and topographic draftsmen in Departmental service; junior engineer draftsmen in Engineer Department at large; junior chemist in departmental service; laboratory apprentice in Bureau of Standards; local inspectors and assistant inspectors of boilers and of hulls.

October 13: Agricultural inspector, Philippine Service; aid Bureau of Standards; aid, cadet engineer and cadet officer, Lighthouse service; fish culturist and apprentice fish culturist; assistant observer, Weather department; civil engineer and draftsman; computer, Nautical Almanac Office and Naval Observatory; mechanical and topographic draftsmen, Panama Canal service; ship draftsman, Navy Department; engineer, Indian service; junior mechanical or electrical engineer, Engineer Department at large; junior mining engineer, Bureau of Mines; laboratory assistant,, Bureau of Standards; library cataloguer; scientific assistant, Department of Agriculture; statistical clerk, departmental service.

Personal Notes

H. M. Montgomery, chairman of the Chicago section of the American Society of Mechanical Engineers, has been elected vice president and director of the Powdered Coal Engineering & Equipment Company, of Chicago, which is preparing elaborate plans for the construction and equipment of a large demonstration plant and research laboratory in Chicago, where working demonstrations of the adaptation of powdered coal as a fuel to all forms of heat production will be carried on under engineering observation, aided by every influence that scientific research can bring to bear on the production of perfect combustion.

E. A. Kingsley, formerly city engineer and superintendent of public works in Little Rock, Ark., the first state highway engineer of Arkansas, and more recently, until July 1, supervising engineer of the construction of the $700,000 highway system of Bell county, Tex., has been appointed paving engineer of San Antonio, Tex., by street commissioner Kearny. The city began a system of paving recently and under the new commission form of government plans to extend the system. At the last June meeting of the commission, the street commissioner was authorized to call for bids on thirteen paving contracts on eleven streets, and bids were received for paving one street. Other streets will follow rapidly. Mr. Kingsley's experience has been ample to insure his success in his new position, which is in the nature of a deserved advance.

H. E. Bilger, M. Am. Soc. C. E., road engineer, Illinois state highway department, Springfield, Ill., was granted the degree of Master of Science, pro merito, by Bucknell University, Lewisburg, Pa., on June 16, 1915. He is a graduate of the university and also of the University of Missouri. He has had extensive engineering experience in the service of railroads and in municipal and industrial projects. For six years he was with the Illinois highway commission as assistant engineer and division engineer, resigning to become senior highway engineer with the U. S. Office of Public Roads, assigned to the southwestern states at the construction of object-lesson roads, and in the analysis of county road conditions and the formulation of reports thereon for the bases for bond issues for road improvement. In April, 1914, he resigned from this position to accept his present position, which was won by an open examination with 103 competitors. He now has immediate technical charge, under the general direction of the chief state highway engineer, of all road work coming under the supervision of the Illinois state highway department.

All on Four Wheels

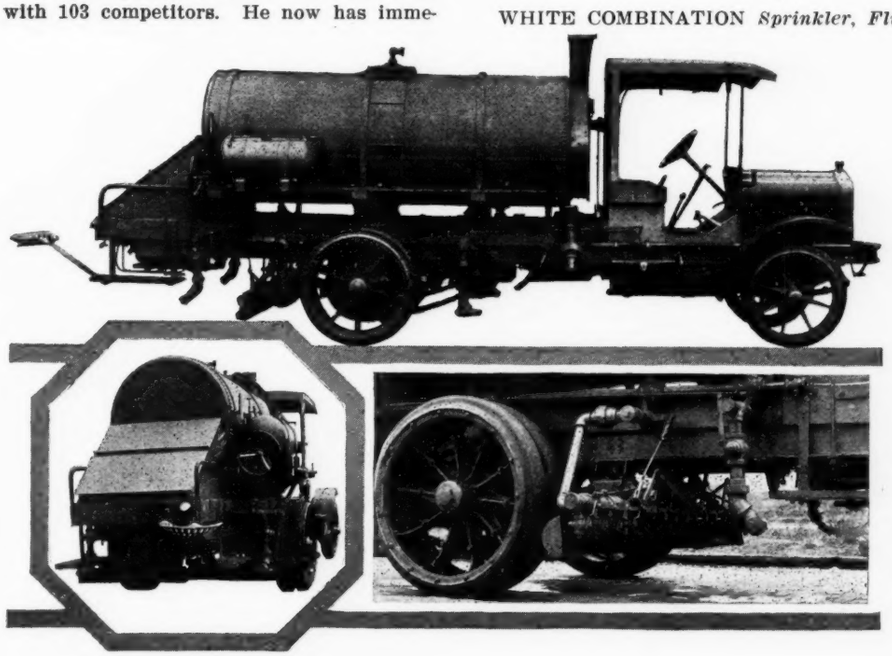
Each year increasing care is taken to conserve streets and highways. The top dressing of macadam pavements must be preserved by oiling which is also a great help in keeping down the dust. Then, too, the streets must be sprinkled daily during the dusty weather and periodically they should be thoroly cleaned and flushed.

The city of Indianapolis, Ind., has provided for this attention to its paths of transportation by purchasing a White combination sprinkler, flusher and road oiler. The apparatus is mounted on a White 5-ton chassis and the equipment includes a 1,200-gallon tank for either water or oil, a set of sprinkler nozzles, mounted under the rear of the tank, busher nozzles at the forward end of the tank, the necessary apparatus for road oiling and a rotary gear pump operated from the power transmission. The heater is operated by gasoline, supplied from a small tank mounted on the right side of the body. The oil nozzles, sixteen in number, are supported on a rack under the rear of the tank and are so constructed that the entire rack may be moved a distance of 2 feet from the center position to either the right or left. This shifting is controlled from the small seat at the extreme rear of the truck.

The water or oil may be taken into the tank thru an opening in the top or pumped in thru the intake pipe at the front of the tank. When the apparatus is in operation, the water or oil, as the case may be, is pumped from the tank to the proper set of nozzles and the flow is controlled entirely from the driver's seat. Three-way valves are provided in the pump line so that when one set of nozzles is in operation, the other two may be completely cut off.

The heater is placed on the rear of the frame and hot air is circulated thru coils in the tank and out thru a uue at the front of the tank.

The entire equipment is very compact and so arranged on the chassis that everything is easily accessible and each operation is handily controlled.



WHITE COMBINATION *Sprinkler, Flusher and Oiler.*

MACHINERY AND SUPPLIES

Extensive Road Construction in Oregon

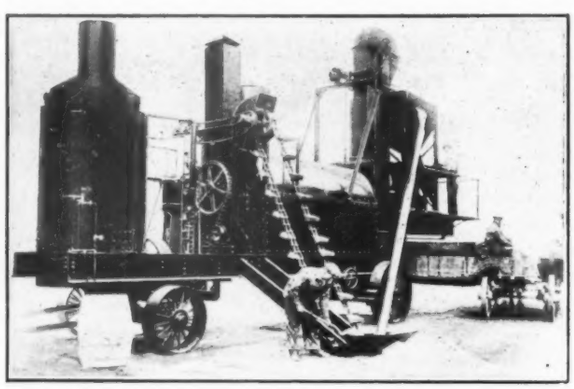
The commissioners of Multnomah county, Oregon, in which Portland is situated, have recently let contracts for 88 miles of road construction, at an average cost of $14,000 a mile, or a total of about $1,250,000, under a bond issue approved during the winter. The contracts for concrete roads aggregate 13 miles and for brick 1 mile, the remaining contracts are for Warrenite, distributed among four contractors: Warren Construction Co., Portland, 40 miles; Pacific Bridge Co., Portland, 12 miles; Oscar Huber, Portland, 10 miles; Clark & Henry, California, 12 miles. The standard width is 16 feet.

As in most sections of the country, the macadam roads of Multnomah country have proved insufficient to sustain the ravages of modern automobile traffic, but provide an excellent foundation for a modern permanent road surface. The project for improvement on a large scale began nearly two years ago, when, at a conference meeting of the most prominent taxpayers of the city of Portland and Multnomah county, John B. Yeon and S. Benson were urged to accept the positions of roadmaster and deputy roadmaster respectively. They have since devoted nearly their entire time to investigation of the road problem, including roads of all types thruout the United States and Canada.

New Portable Asphalt Mixing Plant

A new portable asphalt mixing plant having a number of distinctive features has just been put on the market by the Iroquois works of the Barber Asphalt Paving Company, Buffalo. For a plant of its size and cost it is unusual in having a minimum capacity of 800 square yards of 2-inch sheet asphalt topping per day of 10 hours. The capacity for asphaltic concrete, Topeka mix, or asphalt macadam is much larger.

The mixing platform of the plant is so elevated that a wagon can be driven under it to receive the load from the mixer without elevating the plant on its wheels or excavating for this purpose. The platform is arranged for one-man operation, the levers for controlling clutches and plant being within easy reach. The mixer is a two-shaft, pugmill type, with removable side and end liners; provided with two full sets of blades, the binder blades being solid manganese. The sand-measuring box and asphalt bucket are supported on scales. A drying drum of special construction has been designed for this plant to obviate the difficulties so often encountered in heating a sufficient amount of sand and stone. Features that count in the economical upkeep of such plants as this are the removable steel wearing plates in the material chutes, and chilled rims for all chain sprockets.



As illustrated, the plant would be operated as two units, the second unit being the asphalt kettle. The mixing plant is also supplied, however, without boiler and engine. In other words, the contractor or municipality already provided with portable boiler, engine and kettles, can secure the mixing plant without making an additional investment for these units.

The plant is designed especially to meet the requirements of contractors and municipalities having new construction and maintenance work to perform in scattered territory, or in an amount insufficient to make a stationary plant economical.

Improved Creosote Oil

The Republic Creosoting Co., of Indianapolis, are issuing a new booklet on improved creosote oil, which gives also the specifications for the Reilly improved creosote oil.

The booklet presents an excellent argument for making clear distinction between creosote oil and mixtures of creosote with tar or petroleum or asphalt or resin or any other material, so that the names used for the various compounds will give an indication of their composition. This seems to be a fair proposition and it follows the principle on which the specifications thus far adopted by the American Society of Municipal Improvements are based. The compounds seem to be advocated because they are considered equally or even more valuable and should have the full advantage of these points of superiority. They do not have this advantage if they are called creosote.

Bleeding of paving blocks is attributed in the booklet to the mixture with creosote of other materials to produce the oil with which they are treated.

The distinguishing characteristics of the Reilly improved creosote oil are stated to be high degree of penetration into the fibers of the wood, stability, preservative properties, waterproofness, high specific gravity and high boiling point. The value of each of these characteristics is more fully set forth in the booklet than there is space for here.

Full specifications for the Reilly improved creosote oil close

the booklet and include some of the tests for adulterants, with recommendation that other tests be used when other kinds of adulteration may be suspected.

The claims for this oil are for properties which the writer has for years considered to be the essentials of a perfect oil for treating wood paving blocks, and it is now on the market to demonstrate its ability to meet these requirements.

The Turbine Sewer Machine for Cleaning Difficult Sewer Stoppages

The turbine sewer cleaner is claimed by its manufacturers to be able to clean any stoppage in a sewer no matter how difficult for other methods. The device consists essentially of runners and cutters, adjusted to fit the sewer, revolved by water pressure and pushed along with rods, or cables and windlass or jack. In operation a hose is attached and water delivered to the turbine at 60 pounds pressure, giving 3 h. p. to the cutters which revolve at about the rate of an electric fan. The revolving cutters dislodge the material, cut the weeds, roots and other growths, grinding the other matter and carrying it away by the force of the water. At the same time the moving water scrubs the walls of the sewer. The runners and cutting knives can be adjusted so as to exactly fit the sewer. The special turbine windlass is simply constructed and easily set up and is used with cable for drawing the turbine through the sewer. Where windlass and cable cannot be used, as in completely stopped sewers, the forcing jack and sewer rods are used. Special non-buckling galvanized iron rods with special couplings to withstand the strain may be obtained. Wooden rods which float in 2½ inches of water are used in pulling cable or rope thru the sewer.

The turbine device has been widely and successfully used in many cities. Henry J. Kruse, superintendent of sewers of Milwaukee, Wis., cleaned 319 feet of 12-inch sewer, choked with grease, in 16 hours with four men at a cost of $16, or 5 cents a lineal foot, whereas laying new sewer at this time would have cost $3 or $4 per foot. Kansas City, Mo., cleaned 7,801 feet of sewer in 14 days at a cost of 0.0315 cents per foot. The average cost of cleaning is put at about 3½ cents per foot with this device.

The illustration shows the windlass and forcing jack and some of the tar removed from a sewer at Fond du Lac.

The turbine sewer machine, the windlass, jack and rods are made by the Turbine Sewer Machine Renovating Co., Inc., Milwaukee, Wis.

TURBINE SEWER CLEANING *machine removing tar from a sewer at Fond du Lac, Wis.*

Bitulithic in Corpus Christi

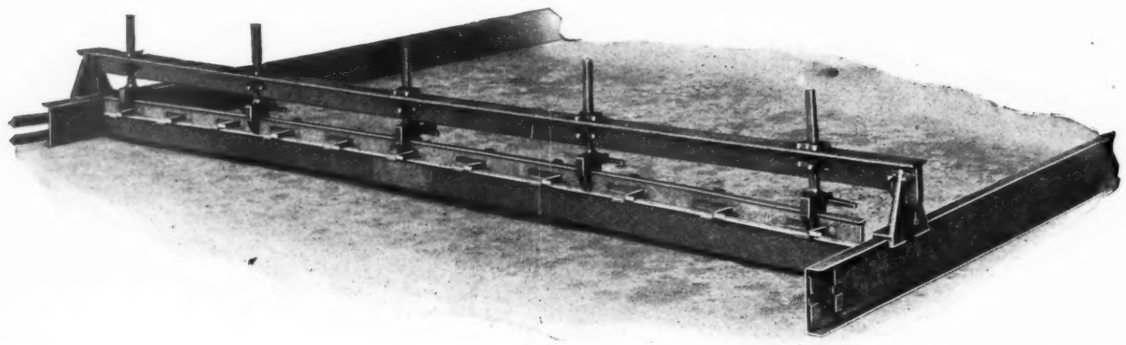
On June 1, 1915, the city of Corpus Christi, Texas, awarded a contract for 80,000 square yards of bitulithic pavement on sixteen main thorofares and leading residential streets to the Texas Bitulithic Company, of Dallas, Texas. This contract calls for an expenditure of $275,000, the property owners paying three-fourths of the costs for the paving in front of their property, and the city paying the remaining one-fourth and all of the costs of paving street intersections. When this contract is completed, Corpus Christi will be one of the best paved cities in America.

In September, 1912, the city of Corpus Christi awarded its initial paving contract to the Texas Bitulithic Company, of Dallas, Texas, for bitulithic on seventeen downtown streets, 150 blocks, for $350,000, being the largest single paving contract ever awarded in the state of Texas. There was very keen competition for this contract, bids being received for paving with bitulithic, wood block, brick, asphalt and concrete.

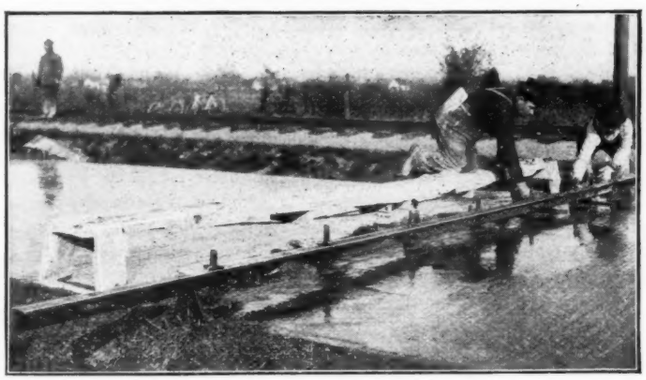
A committee composed of members of the city council and the advisory citizens' committee visited several cities to inspect the different kinds of pavement, and upon their recommendation, the city council let the entire contract for bitulithic pavement. The actual paving work was delayed for several months, giving the property owners ample time to provide sewer connections in the streets to be paved. That bitulithic is satisfactory is demonstrated by this second large contract for streets of the same material.

The Installation of Kahn Armor Plates

The improved device for installing Kahn armor plates provides a space between the supporting T bar and the armor plates, so that the pavement can be finished evenly over the top of the plates. The clamps suspended from the T-bar are



INSTALLING DEVICE *for setting Kahn joint protectors for concrete pavements.* ABOVE, *set to fit crown of pavement and ready for placing of concrete;* BELOW, *concrete in place and workmen finishing top over the joint readily because of space between T-bar and top of pavement.*



adjustable in length so as to provide an absolutely accurate crown. The steel wedge in these clamps holds the plates tightly together. The T-bar is supported from the side forms by means of the steel stools, in which are adjusting bolts for raising or lowering the entire assembled joint. This same installing device may be used for roads of any crown and various widths.

Accompanying illustration shows the new installing device set up and adjusted to crown, with supporting stools adjusted to width and armor plates clamped together with elastite middle clamp close up against T-bar. The plates at this point should be approximately 2 inches from the edge of T-bar. The end clamps are next adjusted farther away from the T-bar to represent approximately the full crown of the plates. In other words, if we have a 2-inch crown, our plates being 2 inches from the T-bar at the middle, the end clamps will be so adjusted to bring the ends of the plates exactly 4 inches from the T-bar. The armor plates are then placed in the device and the intermediate clamps are adjusted to the crown of the plates.

After T-bar is assembled, open all clamps by driving out the wedge, adjust position of clamps as previously described, place armor plates and filler, lock securely by means of the bottom lock nut and drive wedges securely into place, thereby closing jaws of clamps which, thru virtue of their beveled shape, cannot close without holding both plates exactly in position. The assembled plates and device are next placed on the side forms with wedge portion of the clamps towards the mixer. The next operation will be to so adjust the end stools that the tops of the assembled plates are in their approximate vertical position.

In the wider roads and streets some tendency to sag at the middle will be noted in the T-bar. This feature can be readily overcome by maintaining the middle clamp to its proper place and then lowering the end and intermediate clamps until this tendency to sag is overcome. This operation should be performed after the device has been set in the road as represented in illustration. The installing device is removed from the armor plates when the concrete has set sufficiently to finish the surface at that point. Removal is accomplished after driving back wedges and opening up the jaws.

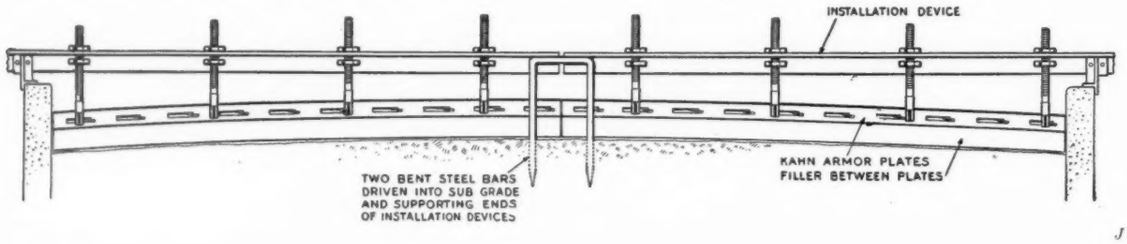
Where the street is over 24 feet in width, two T-bars should be used to span across the street because of the excessive weight and clumsiness of a single device. The clamps and tools will then be adjusted and the armor plates installed. Two bent stakes, furnished by the manufacturers, are first driven into the sub-grade at the middle of the road so that the ends of the two bars rest upon them at the correct height.

We are also illustrating improved types of forms for concrete curb, as well as T-bar for holding curb bar in position. When wood forms are used the plank should be 2 inches in thickness and planed smooth on the inside. The bottom of the curb should have a slight footing, which is easily secured by raising the forms 3 inches above the foundation and allowing a portion of the concrete to slope off underneath. The curb bars may be readily installed by either of two methods:

1. With special T-bar. 2. By merely pressing the curb bar into the concrete.

The T-bar, as indicated in illustration, serves also the purpose of holding the forms the correct distance apart. When the clamp for holding the forms from spreading is set in place, the T-bar is clinched very tightly. In this T-bar is a slot,

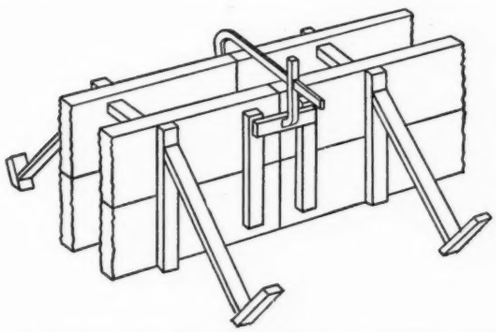
INSTALLING DEVICE *for Kahn joint protector plates as arranged for streets over 24 feet wide, with a support for the two T-bars in the middle of the street.*


INSTALLATION DEVICE
KAHN ARMOR PLATES
FILLER BETWEEN PLATES
TWO BENT STEEL BARS DRIVEN INTO SUB GRADE AND SUPPORTING ENDS OF INSTALLATION DEVICES

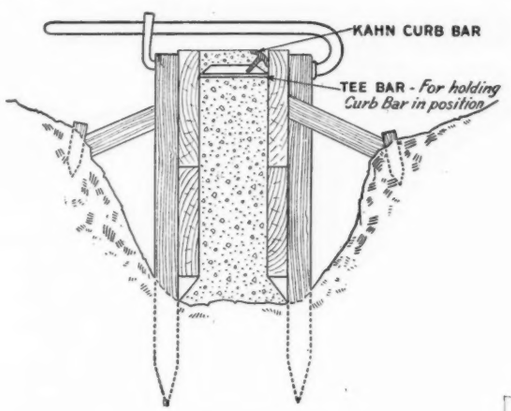
which is set at the right angle to hold the curb bar in proper position. The concrete is then poured and floated level with the top of the form and curb bar.

The T-bar can be entirely dispensed with by using wood sticks to separate the forms and bringing the concrete up to the level of the top of the curb and then pressing the curb into its correct position.

The specialties above referred to are made by the Trussed Concrete Steel Co., Detroit, Mich., and Youngstown, Ohio.



IMPROVED WOOD FORMS *for making concrete curb, showing also protecting bar for curb corner, T-bar for keeping forms apart, clamp for keeping them together and braces for keeping them in position.* ABOVE, *forms in place;* BELOW, *cross-section of curb during construction.*



Trade Notes

Foster & Creighton Co., engineers and contractors, Nashville, Tenn., have entered into an agreement to take all contracts for the Harris municipal garbage incinerator and steam generator in which a sum of $50,000 or more is involved. The Nashville Bridge Co. will continue to take contracts amounting to less than $50,000.

The city of St. Louis, Mo., in rewriting their specifications for brick paving have included the following phrase: "They shall be unrepressed, side wire cut in such a manner that lugs will be formed during the process of cutting, and shall have the ends beveled." The recognition of the advantages claimed for wire-cut-lug brick is obvious. St. Louis is one of the largest consumers of vitrified paving brick in the country, and the change from the repressed brick to the unrepressed brick was only made after investigations which have extended over a period of more than six years.

Mechanical Trench Tamping

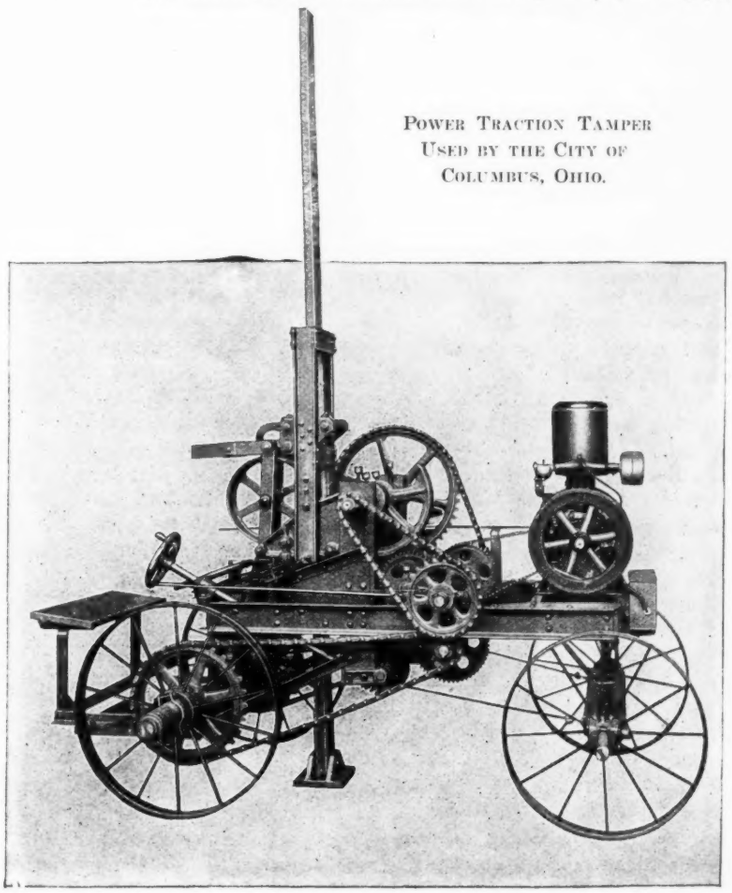
By W. A. Kellogg, General Foreman of Water Works, Columbus, Ohio.

For many years there has been a strong demand for power traction tampers for the mechanical tamping of trench backfill on streets up for improvement. Our experience in this direction may be of interest, as we are now operating such machines, particularly on long main feeder lines minus cross ditches. On unimproved streets we do no tamping, either by hand or machine, merely flushing to top.

Aside from the slowness of hand tamping, the main objection has been that laborers are liable to neglect their work. It is an easy matter for a hand laborer to permit a hand tamp to merely drop while seeming to push or to slip his hands up and down on the tamping shaft. There is little system in hand tamping—you can never be positively sure whether the fill is really tamped or not. The surface of the fill may be smoothed by hand tamping irons, but only careful inspection will prove effectiveness of hand operation. Then, again, while the top layer may be effectively packed, you have no way of telling whether layers were hand tamped every 6 inches or every 12 inches.

There are, of course, many soils to cope with, but each must be treated on the same general princicle, i. e., to fill all the voids, that in every case all the particles may be as close together and as tightly compacted as possible, and it is my opinion that this result can only be accomplished by mechanical tamping. We have in successful operation two paver traction tampers with which we tamp any kind of soil we would attempt to tamp by hand. In other words, our machines tamp all soils ecept sand, and sand we would not attempt to hand tamp.

We invariably use 42 inches of covering for any size pipe,



POWER TRACTION TAMPER USED BY THE CITY OF COLUMBUS, OHIO.

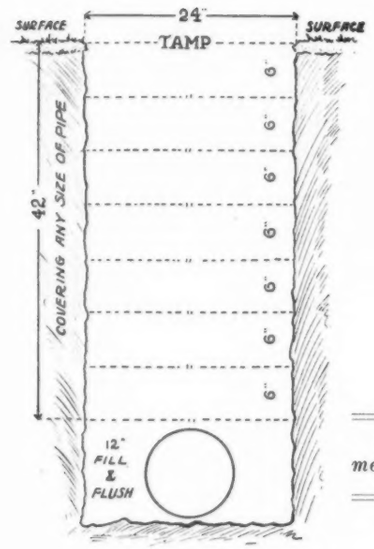


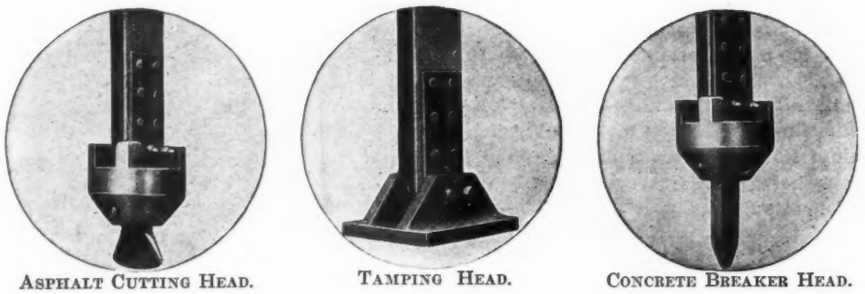
FIGURE 1. *Illustrating method of fill and tamping.*

except in instances where cuts are not graded out and we have to go deeper. We place a 12-inch fill over pipe line and flush in order that the soil may become firmly packed around pipe at bottom and then mechanically tamp every 6 inches to top, as shown in Fig. 1. Sizes of pipe to widths of trench are as follows:

6-inch to 8-inch pipe	24-inch trench
12-inch to 16-inch pipe	30-inch pipe
20-inch and 24-inch pipe	36-inch trench
36-inch pipe	48-inch trench

Each of the two traction tampers, above referred to, and which have been used most successfully in this department, is operated by but one man and moves forward under its own power at a maximum speed of 1 1/3 miles per hour. A feeding speed of approximately 6 feet per minute is provided to furnish a continuous slow movement forward or backwards when at work on the trench. The tamping head moves across the machine on a solid steel runway. The weight of the tamping ram and its carriage is supported on 6-inch rollers. The tamping head is 9x12 inches, and has a maximum cross travel of 16 inches, thus enabling it to actually cover 27 inches of trench. Since it is not necessary to tamp closer than 4½ inches to the wall of the trench in most cases, the machine will handle a 36-inch trench. The tamping head is fastened into the bar of the ram by means of heavy bolts placed thru the lugs on the head. By removing these bolts, the asphalt cutting head, or the concrete breaker head, may be substituted. In cutting asphalt, the knife is set to run in the direction desired to cut, that is, it may be set to cut the parallel lines of the trench, and then turned at right angles, to cut cross sections. The concrete breaker head may be set without reference to direction, and is attached as above described. The tamping ram is operated by means of a segmental pulley, brought in friction contact with the hardwood ram, by spring pressure on a large pulley on the opposite side of the ram. This segment is caused to revolve approximately 42 times per minute, and, of course, causes a stroke of the ram at each revolution. This stroke has an average of 26 inches travel, and as the ram and tamping head together weigh 150 pounds, a thoro packing of the earth results. When considered in comparison with hand labor, the machine shows its worth very forcibly.

The axles are of the stub type, which may be removed at very little expense, should there be occasion for so doing. These stubs are all extended, to permit widening and narrowing of the tread from a minimum of 4 feet 8 inches to a maximum of 6 feet 8 inches. The wheels of either side of the machine may be adjusted without regard to the other side, since it may be necessary to leave the wheels of one side close to the trench, on account of narrow berm. This may be regulated to suit conditions, and the wheels may be placed at any point within the range of adjustment.



ASPHALT CUTTING HEAD. TAMPING HEAD. CONCRETE BREAKER HEAD.

By changing the ram and substituting a cutter for the tamper head, these machines may be used for cutting asphalt previous to excavating. The machine is set to travel forward at tamping speed and cuts a clean, sharp slit in the pavement which penetrates to the concrete base. After the machine travels the length of the trench it cuts the other side on its return trip. This strip can then be crosscut by changing the direction of the cutter head and the asphalt is removed in clean-cut pieces which may afterward be used for replacing the pavement.

Our experience has proven that the one man required to operate the machine keeps two shovelers busy. These three men not only take the place of sixteen hand tampers and two shovelers at $2.25 per day, but they do more and better work. The machine sets the pace for the shovelers. In view of the fact that the operator, who rides, likes to see the other fellow work, he can be depended upon to set a hot pace. The tamping is thoroly done and it is uniform. Every stroke of the 150-pound ram is of the same length. It strikes forty-two 9x12 150-pound blows per minute and not more than one blow

FIGURE 2. *Illustrating location of blows of hand tamper when it is uniformly and efficiently done.*

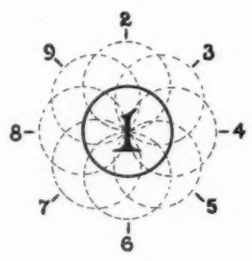
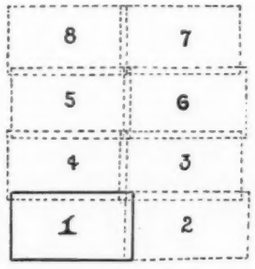


FIGURE 3. *Illustrating greater area covered by blows of mechanical tamper, not more than one blow being required in one spot.*



in a spot. As shown by Fig. 2, a hand tamper may strike many times in the spot or he may not. Hand tamps must necessarily over-lap to a great extent if the work is properly done. Consider this loss of time and inefficient result secured by a 6 to 7-inch 12-pound hand tamp, which is usually dropped not more than 8 to 10 inches at the rate of 15 to 20 strokes per minute, to machine tamping:

Tarvia

Preserves Roads Prevents Dust—

A tarviated road invariably means—increased property values and lower road taxes.

MODERN engineers recognize that the automobile has come to stay and they build roads accordingly.

Experience has taught them that ordinary macadam cannot resist motor-car traffic. The rear wheels tear the fine stone loose and the surface blows away in the form of dust.

You have often seen this process of road disintegration. A dusty road always means *the road is wasting away.* The way to build macadam roads today is to use a powerful binder such as Tarvia, which not only adds greatly to the life of the roadway by making it automobile-proof, but also makes it dustless and mudless.

And of great importance, the reduction in maintenance expenses made possible by this treatment usually *more than pays for the cost of the Tarvia.*

Thousands of miles of roadway have been treated in this way. In fact, some towns have settled down to the policy of building tarviated roads exclusively, wherever possible.

They have done this solely from the standpoint of saving money, because the use of Tarvia means *better* roads at *lower* cost.

Tarvia is made in three grades to meet varying conditions.

Illustrated Booklet on request.

Special Service Department.

This Company has a corps of trained engineers and chemists who have given years of study to modern road problems.

The advice of these men may be had for the asking by anyone interested.

If you will write to the nearest office regarding road problems and conditions in your vicinity the matter will have prompt attention.

BARRETT MANUFACTURING CO.

New York Chicago Philadelphia Boston
St. Louis Cleveland Cincinnati
Pittsburgh Detroit Birmingham Kansas City
Minneapolis Salt Lake City Seattle

THE PATERSON MFG. CO. Limited: Montreal
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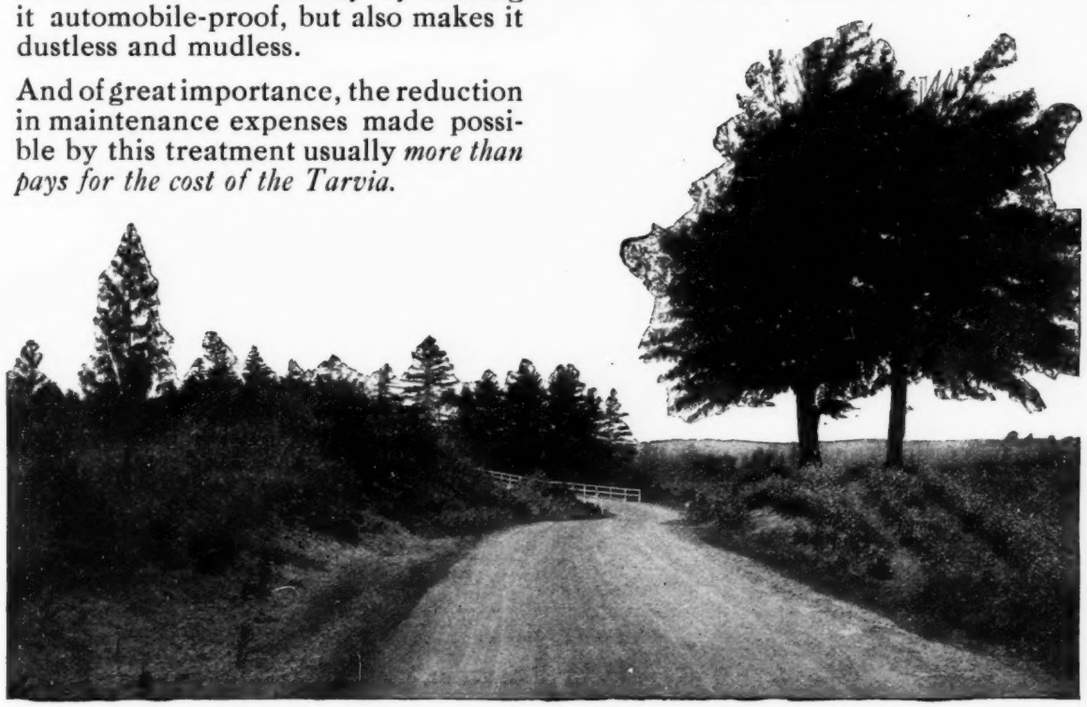


Tarviated Road, New York State Highway, Watertown—Carthage. Note the firm, dustless, easy-traction surface.

	Hand Tamping	Machine Tamping	Machine Gain
Size of ram	4 to 6 inches	9x12 inches	5x6 inches
Weight of head	15 lbs.	150 pounds	135 pounds
Strokes per minute	15 to 20	42	22
Length of drop	8 to 10 inches	26 inches	16 inches

The above table is of special significance when considering that the great area of machine head, with the exception of a slight overlap, never drops in one place more than one time. Then it never tires, nor soldiers on the job, neither does it require refreshments. The two machines which we have in operation are made by the Pawling & Harnischfeger Co., Milwaukee, and have been used on different sized jobs, the following list being representative:

Lilly Ave. (Main to Livingston)	4,000 ft.	8-inch pipe
Sandusky (Sullivan to Mound)	2,100 ft.	20-inch pipe
Mound (Sandusky to Center	1,000 ft.	20-inch pipe
State St. (4th to Grand)	1,600 ft.	12-inch pipe
Cleveland Ave. (12th Ave. to 17th Ave)	1,600 ft.	16-inch pipe
Neil Ave. (Northwest to Dodrich)	2,400 ft.	8-inch pipe
4th Ave. (St. Clair to Howard)	800 ft.	8-inch pipe

Kelly Makes Successful Trailer Tests

Kelly chasses recently made some successful trailer tests with the Troy Wagon Works Company, of Troy, Ohio, manufacturers of Troy trailers.

During these tests the Kelly special 120-inch wheel-base 3½-ton chassis built for tractor purposes, hauled two Troy trailers, each trailer weighing two tons and each carrying a live load of five tons, up a 5.6 per cent. grade. The Kelly tractor carried a 3,300-pound weight over the rear wheels and the gross weight of the trailers and loads was more than fourteen tons. The total weight carried and pulled by the chassis was approximately 15½ tons.

On a level road using a 150-inch wheel-base, 5-ton chassis as a tractor, the two trailers were hauled at the rate of better than 11 miles an hour.

A 5-ton chassis also took one of these trailers up an 8½ per cent. grade in excellent shape. One trailer was hauled up a 7 per cent. grade on second speed and was also started on second speed.

The 5-ton tractor hauled one trailer with gross weight of more than 7 tons a distance of 9 miles in 36 minutes at the rate of 15 miles an hour. There were several grades on this road.

In another cross-country run from Troy, Ohio, to Covington, Ohio, to Piqua, Ohio, a total distance of 27 miles, the 5-ton tractor hauled one trailer under load at the rate of 11 miles an hour thru a soft sand road, and on the harder roads at the rate of 16 miles an hour.

These tests were satisfactory in every way and showed wonderful possibilities of Kelly trucks used in connection with trailers.

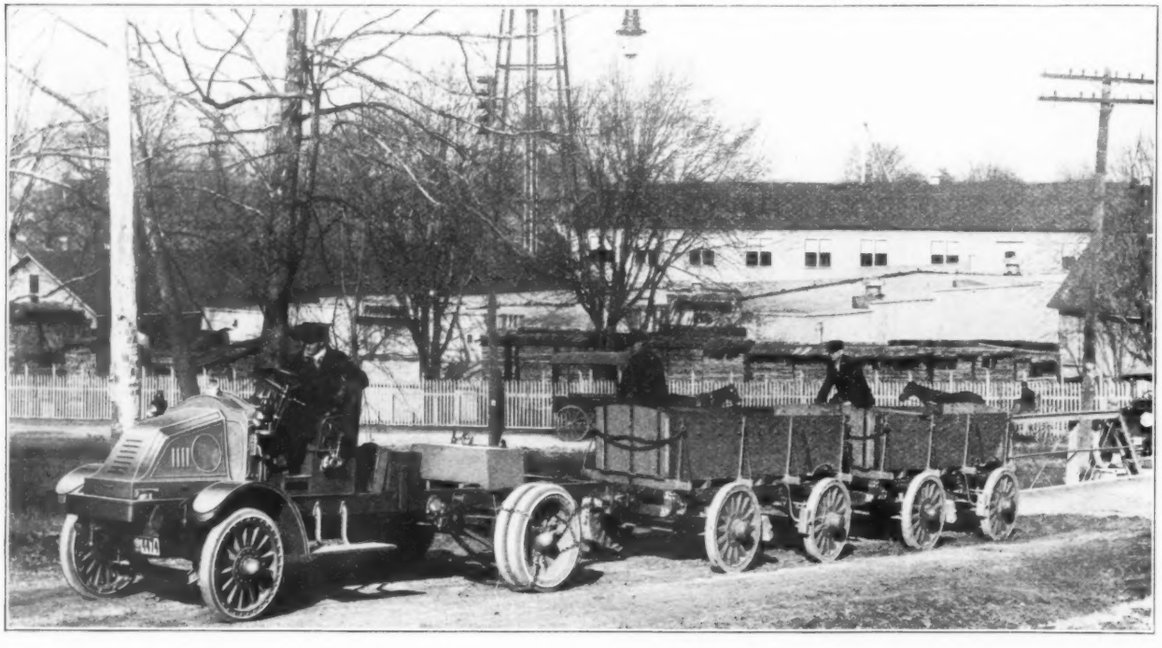
Koehring 1916 Changes

The Koehring mixers for 1916, which are now ready for delivery, offer a variety of refinements and improvements in details of construction, if not in principles of design.

A new characteristic feature, both of side loaders and paving machines, is an automatic brake on the loading skip, which, after the clutch knockout has stopped the skip in charging position, holds it there until released. This is a safety factor, and, on pavers especially, aids in speedy operation. It enables the operator to start the loading skip before the batch is entirely discharged, and then attend to reversing the discharge chute, turning in the water and shooting out the distributing bucket before lowering chute.

Several minor changes more perfectly centralize control. On steam-powered side loaders, all valves and gages have been brought to charging side. The clutch control on gasoline-powered mixers has also been brought to charging side. On side-loader models, discharge chute has four controls, two on each side of mixer, facilitating discharge when mixer is placed in close, unhandy quarters.

Steam engines are not only housed, but are of enclosed type, the mechanism being effectively dust-proofed by cast plates fitted integrally to the engine. Drum rollers are concaved to prevent cracking. All mixers are now fitted with



A KELLY TRUCK *hauling more than fourteen tons in trailers on a seven per cent grade.*

Don't Experiment when Paving Your Streets

Insist upon BITULITHIC, the Pavement that Renders Unfailing Service

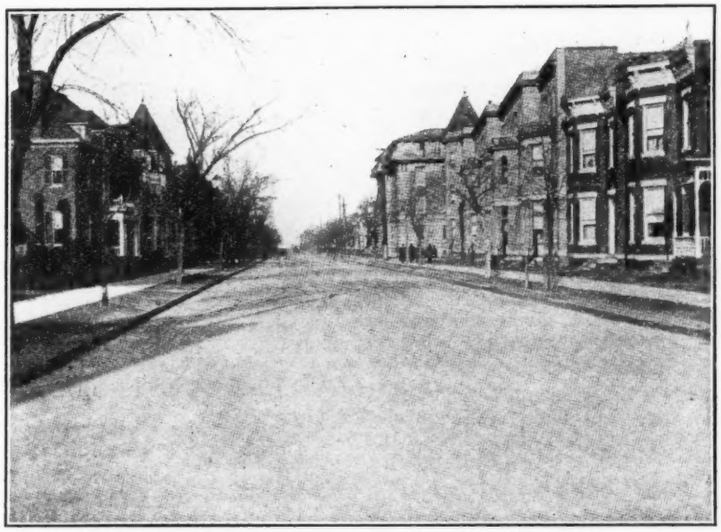
The Demand is Daily Becoming More Insistent and Pronounced for

BITULITHIC

The Pavement which has Proven to be "BEST BY EVERY TEST"

The greatest care is used in the mixing and laying of the **Bitulithic** pavement. It renders unfailing service.

Bitulithic is constructed for all kinds of traffic. It is composed of varying sizes of the best stone obtainable combined with bituminous cement and laid under close laboratory supervision.



The Bitulithic Pavement. Colonial Ave., Norfolk, Va.

You must remember that ***Quality*** should be ***First*** consideration.

Quality First is the Motto of the Bitulithic Pavement.

BITULITHIC

is the development of many years' experience in road building. We are paving specialists and give you the benefit of our experience.

Bitulithic Pavement is the city's best asset, as you will have a well-paved street for years to come.

No Time like the Present to Specify—BITULITHIC

for streets to be paved this spring. The sooner you award your contract for **Bitulithic** the earlier your streets will be ready for use.

Bitulithic is the delight of all automobilists, abutting residents and taxpayers.

A postal card will bring you illustrated booklets regarding **Bitulithic Pavement.**

Why not write a card today to

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Executive Offices: BOSTON, MASS.

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grooved drum for loading skip cable, as protection against binding and chafing of the cable. Extra wide loading skips are provided for all mixers.

A new distinctive feature on heavy duty pavers, Nos. 22, 12 and 20, is the under-slung cross section channels on which the boiler is mounted. On the No. 22, both the engine and boiler are mounted on this section. The object of this under-slung construction is to lower the center of gravity, more effectively counteracting the tendency of a full bucket to tip up one side of mixer when a boom exceeding the standard 20-foot length is extended at right angles. With this same purpose the frames are considerably lowered, and the drum rollers are mounted on a low steel-channel sub-frame.

The new size mixers have the following capacities in cubic yards of unmixed material per hour: No. 16, 20 cu. yds.; No. 10, 12 cu. yds.; No. 22, which is a paver, 32 cu. yds.

New Chicago-Type Road Oiler

E. D. Etnyre & Company, of Oregon, Ill., have recently perfected and placed on the market a road oiler known as the Etnyre Chicago Type pressure road oiler (in view of the fact that the first order was an award for twenty from the city of Chicago), which will distribute oil evenly over a street or road of the usual width with one operation.

The pump used on this machine is of the double rotary type mounted with three heavy bearings on a single base, and driven by means of a chain and sprocket on the rear wheel. A by-pass and automatic governor on the pump enables the operator to obtain any desired working pressure, and also eliminates any danger to the pump when the distributing valves are closed. Timing gears are placed on the shafts of this pump so that the impellers are kept in perfect alignment, which eliminates the wear on the pump case and also the impellers.

The distributing head is of the latest design and is so constructed that the width of oil can be cut down as much as desired on either side of the wagon, or both sides can be cut down simultaneously to any width desired, or the valves can be closed entirely with the same operation. The volume of oil can also be regulated as desired. The discharge opening in the head is designed with a view to distributing a greater amount of oil in the center of the road than on the sides. The construction of the head, complete, being the simplest possible to secure the results desired, is made of solid brass with no small parts or adjustments to wear or get out of order. The control of the head is effected by means of levers at the driver's seat.

This machine also makes a very satisfactory sprinkler for pavements and can be furnished in combination with an improved pipe distributor which consists of two lines of pipe with different sized nozzles in each line, and by means of a special valve either line can be used, or both lines at the same time, which gives a wide variation in the quantity of oil. It is also possible to spread oil two, four, six or eight feet wide, and all operations are controlled by two levers at the driver's seat.

ETNYRE CHICAGO-TYPE *of road oiler operated under pressure.*

Boxed for Export

The illustration herewith shows a Cummer road plant, also a 5-ton Cummer melting kettle boxed for export to Melbourne, Australia, and consigned to the Sims Paving & Roofing Co.

The road plant, consisting of three units, is all in one crate. This plant is identical with type of Cummer plant as described in the June number of MUNICIPAL ENGINEERING, and will be used chiefly for the laying of sheet asphalt in far-away Australia.

Trade Publications

A recent circular of the American Blower Co. discusses the patent litigation over the Sirocco fan.

Engineering Leaflet No. 18, on testing V-notch meters, issued by the Harrison Safety Boiler Works, Philadelphia, Pa., is a reprint of two important papers on the V-notch weir as used in the Cochrane metering heater, one by James Barr, describing apparatus used and results obtained in tests, by which he established that a V-notch weir gives the true discharge within one-third of 1 per cent, and the other by W. S. Giele, describing a commercial testing apparatus for V-notch weirs of different dimensions.

Corrugated iron construction on the Sacramento valley irrigation project is a paper by Eugene C. Mills, chief engineer, which is reprinted and distributed by the National Corrugated Culvert Mfg. Co., of Middletown, O.

The Davis Sewing Machine Co., Dayton, O., issue a circular concerning their Dayton tri-car chemical for light and quick fire service, especially adapted for small towns.

The Solvay Process Co., Syracuse, N. Y., have prepared a handsomely illustrated booklet on Solvay rust-resisting paints, which describes a dozen different varieties for as many kinds of work.